

Wyoming State Capitol Acoustic Treatments Design



**50% CONSTRUCTION
DOCUMENTS**

PROJECT MANUAL

Project # HP21469.2301.00

Issued MARCH 21, 2025

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SECTION 000100 – ARCHITECTS SEAL PAGE

The Architects' seal on these contract documents has been affixed in accordance with the requirements of Title 33 Chapter 4-116 of the Wyoming Statutes. In affixing this seal, the Architect takes responsibility for the attached architectural specifications. The Architect hereby disclaims any and all responsibility for project specifications other than these, included in these project documents, they being the responsibility of the other design professionals, whose seals and statements appear herein.

Architect:

Vance Kelley, AIA,
Architectural License Number WY C-3810
Treanor
1040 Vermont St., Lawrence, KS 66044

Specification Divisions 01-14 unless otherwise indicated

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END OF SECTION 00 0110

SECTION 00 0115
LIST OF DRAWING SHEETS

1.01 LIST OF DRAWINGS

- A. Drawings: Drawings that will be enumerated in the Owner/Contractor Agreement as part of the Contract Documents are listed on the Table of Contents page of the separately bound drawing set titled "Wyoming State Capitol Acoustic Treatments Design" dated 03-21-2025, as modified by subsequent Addenda and Modifications.
 - 1. The words "Resource Drawing" or "For information" after the titles of drawings indicate that those drawings are not intended to be incorporated in the Contract Documents.

END OF SECTION 00 0115

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**SECTION 00 1113
ADVERTISEMENT FOR BIDS**

1.01 PROJECT INFORMATION

- A. Notice to Bidders: Qualified Bidders to submit bids for Project as described in this Document and in accordance with the Instructions to Bidders.
- B. Project Identification: Wyoming State Capitol Acoustic Treatments Design.
 - 1. Project Location: 200 W 24th St., Cheyenne, Wyoming 82001
- C. Owner: State of Wyoming, State Construction Department, Construction Management Division
 - 1. Owner's Representative:
 - a. Brandon VanTassell, Project Manager, Construction Management Division
- D. Architect: Treanor
 - 1. Vance Kelley, AIA.

1.02 PROJECT DESCRIPTION: PROJECT CONSISTS OF NON-HISTORIC WINDOW REPLACEMENT AND REGLAZING OF HISTORIC METAL WINDOWS. ACOUSTICAL DRAPERY IS ALSO INCLUDED.

- A. Construction Contract: Bids will be received for the following Work:
 - 1. General contract (all trades).

1.03 BID SUBMITTAL AND OPENING

- A. Bid Submittal, Printed: Owner will receive sealed Lump Sum bids until the Bid time and date at the location indicated below. Owner will consider bids prepared in compliance with the Instructions to Bidders and delivered as follows:
 - 1. Bid Date: ???Insert date???
 - 2. Bid Time: 2:00 p.m. ???Insert time???, local time.
 - 3. Location: ???Insert bid receipt's location and room name???, ???Insert street address???, ???Insert city, state, and zip code???
 - 4. Bids will be thereafter publicly opened and read aloud.
- B. Bid Submittal, Electronic: Owner will receive electronically submitted bids until the Bid time and date via web-based bidding management software. Owner will consider bids prepared in compliance with the Instructions to Bidders and delivered as follows:
 - 1. Bid Date: ???Insert date???
 - 2. Bid Time: Not later than 2:00 p.m. ???Insert time???, local time.
 - 3. Web-Based Bidding Management Software: ???Insert URL and instructions???
 - 4. Bids will be thereafter opened and read aloud via public webcast and teleconference as indicated in the Instructions to Bidders.

1.04 BID SECURITY

- A. Submit bid security with each Bid in the stipulated form and in the amount identified in the Instructions to Bidders.

1.05 PREBID MEETING

- A. Prebid Meeting: See Document 002513 "Prebid Meetings."
- B. Prebid Meeting, Web Based: A prebid meeting for all Bidders will be held on ???Insert date??? at 10:00 a.m. ???Insert time???, local time. Prospective prime Bidders are required to attend. Register for prebid meeting at URL in "Web-Based Bidding Management Software" Subparagraph in "Bid Submittal and Opening" Article.
- C. Bidders' Questions: Architect will provide responses at prebid conference to Bidders' questions received up to two business days prior to conference. Submit requests for clarification and interpretation using method indicated in Instructions to Bidders.

- D. Site Walkthrough Meeting: A site walkthrough meeting for all Bidders will be held at Project location on ???Insert date??? at 10:00 a.m. ???Insert time???, local time. Prospective prime Bidders are required to attend. Register for site walkthrough meeting as follows: ???Insert registration instructions???.

1.06 BIDDING DOCUMENTS

- A. Bidding Documents, Electronic: Obtain access after ???Insert date??? by contacting ???Insert Owner, Architect, or reprographic house address???. Online access will be provided to prime Bidders only.

1.07 TIME OF COMPLETION

- A. By submitting a Bid, Bidder represents that Bidder will begin the Work on receipt of the Notice to Proceed and will complete the Work within the Contract Time indicated in the Bidding Documents.

1.08 BIDDER'S QUALIFICATIONS

- A. Licenses: Bidders must be properly licensed under the laws governing their respective trades.
- B. Insurance and Bonds: A Performance Bond, separate Labor and Material Payment Bond, and insurance in a form acceptable to Owner will be required of the successful Bidder.
- C. Contractor's Qualification Statement: A completed AIA Document A305, "Contractor's Qualification Statement," with all exhibits is required to be submitted with the Bid.

END OF SECTION 00 1113

**SECTION 00 2113
INSTRUCTIONS TO BIDDERS**

1.01 INSTRUCTIONS TO BIDDERS

- A. AIA Document A701-2018, "Instructions to Bidders," is hereby incorporated into the Bidding Documents by reference.

END OF SECTION 00 2113

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**SECTION 00 2213
SUPPLEMENTARY INSTRUCTIONS TO BIDDERS**

1.01 INSTRUCTIONS TO BIDDERS

- A. Instructions to Bidders for Project consist of the following:
 - 1. AIA Document A701-2018, "Instructions to Bidders
 - 2. The following Supplementary Instructions to Bidders that modify and add to the requirements of the Instructions to Bidders.

1.02 SUPPLEMENTARY INSTRUCTIONS TO BIDDERS, GENERAL

1.03 THE FOLLOWING SUPPLEMENTS MODIFY AIA DOCUMENT A701-2018, "INSTRUCTIONS TO BIDDERS." WHERE A PORTION OF THE INSTRUCTIONS TO BIDDERS IS MODIFIED OR DELETED BY THESE SUPPLEMENTARY INSTRUCTIONS TO BIDDERS, UNALTERED PORTIONS OF THE INSTRUCTIONS TO BIDDERS WILL REMAIN IN EFFECT.

1.04 ARTICLE 2 - BIDDER'S REPRESENTATIONS

- A. Add the following to 2.1:
 - 1. .7 The Bidder has investigated all required fees, permits, and regulatory requirements of authorities having jurisdiction and has properly included in the submitted bid the cost of such fees, permits, and requirements not otherwise indicated as provided by Owner.
 - 2. .8 The Bidder is a properly licensed Contractor according to the laws and regulations of the State of Wyoming and meets qualifications indicated in the Bidding Documents.
 - 3. .9 The Bidder has incorporated into the Bid adequate sums for work performed by Installers whose qualifications meet those indicated in the Bidding Documents.

1.05 ARTICLE 3 - BIDDING DOCUMENTS

- A. 3.1 - Distribution:
 - 1. Add the following to 3.1.1:
 - a. Obtain electronic Bidding Documents as instructed in the Advertisement for Bids.
- B. 3.2 - Modification or Interpretation of Bidding Documents:
 - 1. Add the following to 3.2.2:
 - a. Submit Bidder's Requests for Interpretation using form furnished on web-based bidding management software indicated in the Advertisement for Bids.
- C. 3.4 - Addenda:
 - 1. Add the following to 3.4.1:
 - a. Addenda will be transmitted by the issuing office using web-based bidding management software indicated in the Advertisement for Bids.
 - 2. Delete 3.4.3 and replace with the following:
 - a. 3.4.3 Addenda may be issued at any time prior to the receipt of bids.

1.06 ARTICLE 4 - BIDDING PROCEDURES

- A. 4.1 - Preparation of Bids:
 - 1. Add the following to 4.1:
 - 2. 4.1.9 Owner may elect to disqualify a bid due to failure to submit a bid in the form requested, failure to bid requested alternates or unit prices, failure to complete entries in all blanks in the Bid Form, or inclusion by the Bidder of any alternates, conditions, limitations or provisions not called for.
 - B. 4.1.10 Bids shall include sales and use taxes. Contractors shall show separately with each monthly payment application the sales and use taxes paid by them and their subcontractors in the form indicated. Reimbursement of sales and use taxes, if any, shall be applied for by Owner for the sole benefit of Owner.
- C. 4.2 - Bid Security:
 - 1. Add the following to 4.2.1:

- a. Provide bid security in the amount of 5 percent of the bid amount in the form of a cashier's check or surety bond meeting the requirements of 4.2.3.
- D. 4.3 - Submission of Bids:
 - 1. Add the following to 4.3.1:
 - a. Submit printed bids at the time and place indicated in the Advertisement for Bids.
- E. 4.4 - Modification or Withdrawal of Bids:
 - 1. Add the following to 4.4.1:
 - a. .1 Such modifications to or withdrawal of a bid may only be made by persons authorized to act on behalf of the Bidder. Authorized persons are those so identified in the Bidder's corporate bylaws, specifically empowered by the Bidder's charter or similar legally binding document acceptable to Owner, or by a power of attorney, signed and dated, describing the scope and limitations of the power of attorney. Make such documentation available to Owner at the time of seeking modifications or withdrawal of the Bid.
- F. 4.5 - Break-Out Pricing Bid Supplement:
 - 1. Add 4.5.
 - 2. Add the following to 4.5:
 - a. 4.5.1 Provide detailed cost breakdowns no later than two business days following Architect's request.
- G. 4.6 - Subcontractors, Suppliers, and Manufacturers List Bid Supplement:
 - 1. Add 4.6.
 - 2. Add the following to 4.6:
 - a. 4.6.1 Provide list of major subcontractors, suppliers, and manufacturers furnishing or installing products no later than two business days following Architect's request. Include those subcontractors, suppliers, and manufacturers providing Work totaling three percent or more of the Bid amount. Do not change subcontractors, suppliers, and manufacturers from those submitted without approval of Architect.

1.07 ARTICLE 5 - CONSIDERATION OF BIDS

- A. 5.2 - Rejection of Bids:
 - 1. Add the following to 5.2:
 - a. 5.2.1 Owner reserves the right to reject a bid based on Owner's and Architect's evaluation of qualification information submitted following opening of bids. Owner's evaluation of the Bidder's qualifications will include: status of licensure and record of compliance with licensing requirements, record of quality of completed Work, record of Project completion and ability to complete, record of financial management including financial resources available to complete Project and record of timely payment of obligations, record of Project site management including compliance with requirements of authorities having jurisdiction, record of and number of current claims and disputes and the status of their resolution, and qualifications of the Bidder's proposed Project staff and proposed subcontractors.

1.08 ARTICLE 6 - POSTBID INFORMATION

- A. 6.1 - Contractor's Qualification Statement:
 - 1. Add the following to 6.1:
- B. 6.1.1 Submit Contractor's Qualification Statement no later than two business days following Architect's request.
- C. 6.3 - Submittals:
 - 1. Add the following to 6.3.1:
 - a. .4 Submit information requested in 6.3.1. no later than two business days following Architect's request.

1.09 ARTICLE 7 - PERFORMANCE BOND AND PAYMENT BOND

- A. 7.1 - Bond Requirements:
 - 1. Add the following to 7.1.1:
 - a. .1 Both a Performance Bond and a Payment Bond will be required, each in an amount equal to 100 percent of the Contract Sum.
- B. 7.2 - Time of Delivery and Form of Bonds:
 - 1. Replace the first sentence of 7.2.1 with the following:
 - a. The Bidder shall deliver the required bonds to Owner no later than 10 days after the date of a Notice of Intent to Award and no later than the date of execution of the Contract, whichever occurs first. Owner may deem the failure of the Bidder to deliver required bonds within the period of time allowed a default.
 - 2. Replace 7.2.3 with the following:
 - a. 7.2.3 Bonds shall be executed and be in force on the date of the execution of the Contract.

1.10 ARTICLE 8 - ENUMERATION OF THE PROPOSED CONTRACT DOCUMENTS

- A. 8.1 - Proposed Contract Documents:
 - 1. Replace .5 inch 8.1 with the following:
 - a. .5 Enumeration of Drawings: The Drawings constituting a portion of the proposed Contract Documents are identified on the Cover Sheet or Title Sheet of the Drawings titled "Wyoming State Capitol Acoustic Treatments Design" dated 03-21-2025.
 - 2. Replace .6 inch 8.1 with the following:
 - a. .6 Enumeration of Specifications: The Specifications constituting a portion of the proposed Contract Documents are identified on the Table of Contents Sheet of the Project Manual titled "Wyoming State Capitol Acoustic Treatments Design" dated 03-21-2025.
 - 3. Replace .7 inch 8.1 with the following:
 - a. .7 Addenda: Portions of the Addenda constituting a portion of the proposed Contract Documents will be enumerated in the Owner/Contractor Agreement.
 - 4. Replace .8 inch 8.1 with the following:
- B. .8 Other Exhibits: Other Exhibits constituting portions of the proposed Contract Documents will be identified in the Bidding Documents and be enumerated in the Owner/Contractor Agreement.

1.11 ARTICLE 9 - EXECUTION OF THE CONTRACT

- A. Add Article 9.
- B. Add the following to Article 9:
 - 1. 9.1 Subsequent to the Notice of Intent to Award, and within 10 days after the prescribed Form of Agreement is presented to the Awardee for signature, the Awardee shall execute and deliver the Agreement to Owner, in such number of counterparts as Owner may require.
 - 2. 9.2 Owner may deem as a default the failure of the Awardee to execute the Contract and to supply the required bonds when the Agreement is presented for signature within the period of time allowed.
 - 3. 9.3 Unless otherwise indicated in the Bidding Documents or the executed Agreement, the date of commencement of the Work shall be the date of the executed Agreement .
 - 4. 9.4 In the event of a default, Owner may declare the amount of the Bid security forfeited and elect to either award the Contract to the next responsible bidder or re-advertise for bids.

END OF SECTION 00 2213

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**SECTION 00 2600
PROCUREMENT SUBSTITUTION PROCEDURES**

1.01 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 in accordance with Instructions to Bidders.
- B. Procurement Prior Approval Requests: Requests for approval of products or manufacturers from those required by the Contract Documents as defined by product selection procedures in Section 016000 "Product Requirements."
 - 1. Procurement prior approval is required when products or manufacturers are listed in specifications under "Sole Product," "Sole Manufacturer," "Limited List of Products," or "Limited List of Manufacturers" introductory paragraphs.
 - 2. Procurement prior approval is not required when products or manufacturers are listed in specifications under "Non-Limited List of Products" or "Non-Limited List of Manufacturers" introductory paragraphs.
 - 3. Where use of "Sole Product," "Sole Manufacturer," "Limited List of Products," or "Limited List of Manufacturers" introductory paragraphs is not allowed by statute, procurement prior approval request is not required.
- C. 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 the General Conditions and Section 012500 "Substitution Procedures" for conditions under which Substitution requests will be considered following Contract award.

1.02 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.

1.03 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 general intent of the Contract Documents, including level of quality of the Work represented by requirements therein.
 - 3. Request is fully documented and properly submitted.

1.04 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, Electronic: Submit Procurement Substitution Request, using format provided on Project web-based bidding management software site.
 - 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:
 - 3. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
 - 1) Product data, including drawings and descriptions of products and fabrication and installation procedures.
 - 2) Point-by-point comparison of specified and proposed substitute product data, fabrication drawings, and installation procedures.
 - 3) Copies of current, independent third-party test data of salient product or system characteristics.
 - 4) Samples where applicable or when requested by Architect.
 - 5) Detailed comparison of significant qualities of 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.
 - 6) Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - 7) Research reports, where applicable, evidencing compliance with building code in effect for Project, from ICC-ES.
 - 8) 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 proposed substitute.
 - b. Provide certification by manufacturer that proposed substitute 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 product or equipment specified in the application indicated.
 - c. Bidder, in submitting the Procurement Substitution Request, waives the right to additional payment or an extension of Contract Time because of the failure of 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 proposed substitute by means of an Addendum to the Procurement and Contracting Documents.
- C. Architect's approval of 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 SECTION 00 2600

**SECTION 00 4100
BID COVER SHEET**

1.01 BID INFORMATION

- A. Project Name: Wyoming State Capitol Acoustic Treatments Design.
- B. Bid for Prime Contract.
- C. Bidder: _____
- D. Bidder Address: _____
- E. Bid Submitter's Phone Number: _____
- F. Bidder Contractor's License Number: _____
- G. Bid Date: _____
- H. Bid Time: _____, local time.

END OF SECTION 00 4100

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SECTION 00 4113
BID FORM - STIPULATED SUM (SINGLE-PRIME CONTRACT)

PART 1

1.01 BID FORM

- A. Bidder: _____.
- B. Project Name: Wyoming State Capitol Acoustic Treatments Design
- C. Project Location: 200 W 24th St., Cheyenne, Wyoming 82001
- D. Owner: State of Wyoming, State Construction Department, Construction Management Division.
- E. Owner Project Number: ????????
- F. Architect: Treanor.
- G. Architect Project Number: HP21469.2301.00

1.02 CERTIFICATIONS AND BASE BID

- A. Base Bid, Single-Prime (All Trades) Contract: The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by Treanor and Architect's consultants, having visited the site, and being familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor, equipment and services, including all scheduled allowances indicated in Section 01 2100 "Allowances, necessary to complete the construction of the above-named Project, in accordance with the requirements of the Procurement and Contracting Documents, for the stipulated sum of:

1.03 _____ **DOLLARS (\$_____).**

1.04 BID SECURITY

- A. The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish surety as specified within 10 ???Insert number??? days after a written Notice of Award, if offered within 60 ???Insert number??? days after receipt of bids, and on failure to do so agrees to forfeit to Owner the attached Bid Security, as liquidated damages for such failure as follows:
 - 1. In the following amount constituting 5 percent of the Base Bid amount above:
 - a. _____ Dollars (\$_____).
- B. Form of Bid Security: Bidder has attached the following:
 - 1. AIA Document A310-2010, "Bid Bond."
 - 2. Cashier's check.
 - 3. Certified check.
- C. In the event Owner does not offer Notice of Award within the time limits stated above, Owner will return to the undersigned the cashier's check, certified check, or bid bond.

1.05 SUBCONTRACTORS AND SUPPLIERS

- A. The following companies to execute subcontracts for the portions of the Work indicated:
 - 1. Window Work: _____.
 - 2. Finishes (plaster, woodwork, painting) Work: _____.
 - 3. Window Treatment Work: _____.
 - 4. HVAC Work: _____.
 - 5. Electrical Work: _____.

1.06 TIME OF COMPLETION

- A. Time of Completion:
 - 1. The undersigned Bidder proposes and agrees hereby to commence the Work of the Contract Documents on a date specified in a written Notice to Proceed to be issued by Architect, and to substantially complete the Work within ???Insert number??? calendar

days.

2. The undersigned Bidder proposes and agrees hereby to commence the Work of the Contract Documents on a date specified in a written Notice to Proceed to be issued by Architect, and to substantially complete the Work within _____ calendar days.

1.07 ACKNOWLEDGMENT OF ADDENDA

- A. The undersigned Bidder acknowledges receipt of and use of the following Addenda in the preparation of this Bid:
 1. Addendum No. 1, dated _____.
 2. Addendum No. 2, dated _____.
 3. Addendum No. 3, dated _____.
 4. Addendum No. 4, dated _____.

1.08 CONTRACTOR'S LICENSE

- A. The undersigned further states that it is a duly licensed contractor, for the type of work proposed, in ???Insert Project jurisdiction???, and that all fees, permits, etc., pursuant to submitting this proposal have been paid in full.

1.09 SUBMISSION OF BID

- A. Respectfully submitted this ____ day of _____ ???Insert month and year???
- B. Submitted by: _____ (Name of bidding firm or corporation).
- C. Authorized Signature: _____ (Handwritten signature).
- D. Signed by: _____ (Type or print name).
- E. Title: _____ (Owner/Partner/President/Vice President).
- F. Witnessed by: _____ (Handwritten signature).
- G. Attest: _____ (Handwritten signature).
- H. By: _____ (Type or print name).
- I. Attester Title: _____ (Corporate Secretary or Assistant Secretary).
- J. Street Address: _____.
- K. City, State, Zip: _____.
- L. Phone: _____.
- M. License No.: _____.
- N. Federal ID No.: _____.
- O. (Affix Corporate Seal Here)

END OF SECTION 00 4113

SECTION 00 4373
PROPOSED SCHEDULE OF VALUES FORM

PART 1

1.01 BID FORM SUPPLEMENT

- A. A completed Proposed Schedule of Values form is required to be attached to the Bid Form.

1.02 PROPOSED SCHEDULE OF VALUES FORM

- A. Proposed Schedule of Values Form: Provide a breakdown of the bid amount, including Alternates, in enough detail to facilitate continued evaluation of bid. Organize and label contents by section in accordance with the Project Manual table of contents.
1. Provide multiple line items for principal material and subcontract amounts in excess of five percent of the Contract Sum.

END OF SECTION 00 4373

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SECTION 00 4393
BID SUBMITTAL CHECKLIST

PART 1

1.01 BID INFORMATION

- A. Project Name: Wyoming State Capitol Acoustic Treatments Design.
- B. Bidder:
- C. Prime Contract, if applicable:

1.02 BIDDER'S CHECKLIST

- A. To assist the Bidder in properly completing all documentation required, the following checklist is provided for the Bidder's convenience. The Bidder is solely responsible for verifying compliance with bid submittal requirements.
- B. Attach this completed checklist to the Bid Form.
 - 1. Used the Bid Form provided in the Project Manual.
 - 2. Prepared the Bid Form as required by the Instructions to Bidders.
 - 3. Indicated on the Bid Form the Addenda received.
 - 4. Indicated on the Bid Form cost associated with listed Unit Prices.
 - 5. Indicated on the Bid Form cost associated with listed Alternates.
 - 6. Attached to the Bid Form Bid Security in form and for the amount required.
 - 7. Attached to the Bid Form Proposed Schedule of Values Form.
 - 8. Verified that the Bidder can provide executed Performance Bond and Labor and Material Bond as described in the Bidding Documents.
 - 9. Verified that the Bidder can provide Certificates of Insurance in the amounts indicated in the Bidding Documents.
 - 10. Used Bid Cover Sheet provided for electronic bids.

END OF SECTION 00 4393

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**SECTION 00 6000
PROJECT FORMS**

PART 1

1.01 FORM OF AGREEMENT AND GENERAL CONDITIONS

- A. The following form of Owner/Contractor Agreement and form of the General Conditions to be used for Project:
 - 1. AIA Document A101-2017 "Standard Form of Agreement between Owner and Contractor Where the Basis of Payment is a Stipulated Sum."
- B. The General Conditions for Project are AIA Document A201-2017 "General Conditions of the Contract for Construction."

1.02 THE GENERAL CONDITIONS ARE INCORPORATED BY REFERENCE.

1.03 ADMINISTRATIVE FORMS

- A. Administrative Forms: Additional administrative forms are specified in Division 01 General Requirements.
- B. Copies of AIA standard forms may be obtained from AIA Contract Documents:
<https://aiacontracts.com>.

1.04 PRECONSTRUCTION FORMS:

- 1. Form of Performance Bond and Labor and Material Bond: AIA Document A312-2010 "Performance Bond" and AIA Document A312-2010 "Payment Bond."
- 2. Form of Certificate of Insurance: AIA Document G715-2017 "Supplemental Attachment for ACORD Certificate of Insurance 25."
- B. Information and Modification Forms:
 - 1. Form for Requests for Information (RFIs): AIA Document G716-2004 "Request for Information (RFI)."
 - 2. Form of Request for Proposal: AIA Document G709-2018 "Proposal Request."

1.05 CHANGE ORDER FORM: AIA DOCUMENT G701-2017 "CHANGE ORDER."

- 1. Form of Architect's Memorandum for Minor Changes in the Work: AIA Document G710-2017 "Architect's Supplemental Instructions."
- 2. Form of Change Directive: AIA Document G714-2017 "Construction Change Directive."
- B. Payment Forms:
 - 1. Schedule of Values Form: AIA Document G703-1992 "Continuation Sheet."
 - 2. Payment Application, Lump Sum Project: AIA Document G702-1992 "Application and Certificate for Payment" and G703-1992 "Continuation Sheet."

1.06 FORM OF CONTRACTOR'S SWORN STATEMENT: AIA DOCUMENT G907-2022 "SWORN CONSTRUCTION STATEMENT" .

- 1. Form of Contractor's Affidavit: AIA Document G706-1994 "Contractor's Affidavit of Payment of Debts and Claims" .
- 2. Form of Affidavit of Release of Liens on Progress Payments: AIA Document G901-2022 "Conditional Waiver and Release on Progress Payment".
- 3. Form of Affidavit of Release of Liens on Final Payments: AIA Document G903-2022 "Conditional Waiver and Release on Final Payment".
- 4. Form of Consent of Surety: AIA Document G707-1994 "Consent of Surety to Final Payment."

END OF SECTION 00 6000

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**SECTION 01 1000
SUMMARY**

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Phased construction.
 - 4. Contractor's use of site and premises.
 - 5. Coordination with occupants.
 - 6. Work restrictions.
 - 7. Specification and Drawing conventions.
 - 8. Miscellaneous provisions.
- B. Related Requirements:
 - 1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.03 DEFINITIONS

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

1.04 PROJECT INFORMATION

- A. Project Identification:
 - 1. Wyoming State Capitol Acoustic Treatments Design
 - a. 200 W 24th St., Cheyenne, Wyoming 82001
- B. Owner:
 - 1. State of Wyoming, State Construction Department, Construction Management Division
 - a. 200 W 24th St., Cheyenne, Wyoming 82001
- C. Architect:
 - 1. Treanor
 - a. 719 SW Van Buren St, Suite 200, Topeka, Kansas 66603

1.05 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
 - 1. Non-historic window replacement.
 - 2. Reglazing of historic aluminum storefronts.
 - 3. Coordination with existing mechanical systems as necessary.
 - 4. Installation of new horizontal louver blinds.
 - 5. Restoration of historic aluminum doors.
 - 6. Repair and refinishing of existing window surrounds.
- B. Type of Contract:
 - 1. Project will be constructed under a Single prime contract.

1.06 PHASED CONSTRUCTION

- A. Construction work will take place in a single phase.

1.07 CONTRACTORS USE OF SITE AND PREMISES

- A. Use of Site: Limited to work in areas indicated.

1. Limits of Site Disturbance: 40 feet beyond building; 10 feet beyond surface paving and utilities; 15 feet beyond roadway and main utility branch trenches; 25 feet beyond constructed permeable surfaces (such as pervious paving, stormwater detention facilities, and playing fields).
2. Driveways, walkways and entrances: Keep driveway, parking areas and entrances serving the premises clear and available to the Owner, Owners employees and emergency vehicles at all times. Do not use these areas for parking or for storage of materials without prior approval from Owner.
3. 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.
4. Condition of existing grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.08 COORDINATION WITH OCCUPANTS

- A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of specific areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.
 2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.09 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between 6 a.m. to 6 p.m., Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.
- 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 arranging for temporary utility services according to requirements indicated:
 1. Notify Owner not less than two days in advance of proposed utility interruptions.
 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.
 1. Notify Owner not less than two days in advance of proposed disruptive operations.
 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Smoking and Controlled Substance Restrictions: Use of tobacco products , alcoholic beverages, and other controlled substances on Owner's property 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.
- G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
 1. Maintain list of approved screened personnel with Owner's representative.

1.10 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

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

PART 2 PRODUCTS (NOT USED)**PART 3 EXECUTION (NOT USED)****END OF SECTION 01 1000**

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**SECTION 01 2500
SUBSTITUTION PROCEDURES**

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

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

1.03 DEFINITIONS

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

1.04 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use form that is part of web-based Project management software.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.

- i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven business days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 business days of receipt of request, or seven business 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.

1.05 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.

1.06 PROCEDURES

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

1.07 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 business 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: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or

rejected at discretion of Architect.

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 offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Contractor's construction schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.
 - j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 2500

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**SECTION 01 2600
CONTRACT MODIFICATION PROCEDURES**

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

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

1.03 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on web-based Project management software.

1.04 PROPOSAL REQUESTS

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

and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form provided as part of web-based Project management software.

1.05 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: See Section 012100 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.

1.06 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on form provided as part of web-based Project management software.

1.07 CONSTRUCTION CHANGE DIRECTIVE

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 2600

**SECTION 01 2900
PAYMENT PROCEDURES**

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Document 004373 "Proposed Schedule of Values Form" for requirements for furnishing proposed schedule of values with bid.
 - 2. Section 012100 "Allowances" for procedural requirements governing the handling and processing of allowances.
 - 3. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 4. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.03 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.

1.04 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule. Cost-loaded Critical Path Method Schedule may serve to satisfy requirements for the schedule of values.
 - 1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect at earliest possible date, but no later than seven business days before the date scheduled for submittal of initial Applications for 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. Owner's name.
 - c. Owner's Project number.
 - d. Name of Architect.
 - e. Architect's Project number.
 - f. Contractor's name and address.
 - g. Date of submittal.
 - 2. Arrange schedule of values consistent with format of AIA Document G703 .
 - 3. Arrange the schedule of values in tabular form, with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.

- g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent. Round dollar amounts to whole dollars, with total equal to Contract Sum.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment.
4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site.
6. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
7. Purchase Contracts: Provide a separate line item in the schedule of values for each Purchase contract. Show line-item value of Purchase contract. Indicate Owner payments or deposits, if any, and balance to be paid by Contractor.
8. Overhead Costs, Separate Line Items: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
9. Temporary Facilities: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
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.

1.05 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 paid for by Owner.
- B. Payment Application Times: The date for each progress payment is indicated in the Owner/Contractor Agreement. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
- C. Payment Application Times: Submit Application for Payment to Architect by the First day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
 1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.
- D. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 as form for Applications for Payment.
 1. Other Application for Payment forms proposed by the Contractor may be acceptable to Architect and Owner. Submit forms for approval with initial submittal of schedule of values.
- E. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.

3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- F. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- G. Transmittal: Submit signed and notarized electronic original copies of each Application for Payment to Architect by a method ensuring receipt. Include waivers of lien and similar attachments.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- H. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment, subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- I. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
 5. Products list (preliminary if not final).
 6. Sustainable design action plans, including preliminary project materials cost data.
 7. Schedule of unit prices.
 8. Submittal schedule (preliminary if not final).
 9. List of Contractor's staff assignments.
 10. List of Contractor's principal consultants.
 11. Copies of building permits.
 12. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.

13. Initial progress report.
 14. Report of preconstruction conference.
 15. Certificates of insurance and insurance policies.
 16. Performance and payment bonds.
 17. Data needed to acquire Owner's insurance.
- J. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- K. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited to, the following:
1. Evidence of completion of Project closeout requirements.
 2. Certification of completion of final punch list items.
 3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 4. Updated final statement, accounting for final changes to the Contract Sum.
 5. AIA Document G706.
 6. AIA Document G706A.
 7. AIA Document G707.
 8. Evidence that claims have been settled.
 9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 10. Final liquidated damages settlement statement.
 11. Proof that taxes, fees, and similar obligations are paid.
 12. Waivers and releases.

PART 2 PRODUCTS (NOT USED)**PART 3 EXECUTION (NOT USED)****END OF SECTION 01 2900**

**SECTION 01 3100
PROJECT MANAGEMENT AND COORDINATION**

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. RFIs.
 - 4. Digital project management procedures.
 - 5. Web-based Project management software package.
 - 6. Project meetings.
- B. Related Requirements:
 - 1. Section 01 1200 "Multiple Contract Summary" for a description of the division of work among separate contracts and responsibility for coordination activities not in this Section.
 - 2. Section 01 3200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 3. Section 01 7300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 4. Section 01 7700 "Closeout Procedures" for coordinating closeout of the Contract.

1.03 DEFINITIONS

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

1.04 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
 - 1. Post copies of list in Project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in built facility. Keep list current at all times.

1.05 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 and direction of Project coordinator to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Preinstallation conferences.
 - 7. Project closeout activities.
 - 8. Startup and adjustment of systems.

1.06 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 - 1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
 - 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 - 1. Project name.
 - 2. Owner name.
 - 3. Owner's Project number.
 - 4. Name of Architect.
 - 5. Architect's Project number.
 - 6. Date.
 - 7. Name of Contractor.
 - 8. RFI number, numbered sequentially.
 - 9. RFI subject.
 - 10. Specification Section number and title and related paragraphs, as appropriate.
 - 11. Drawing number and detail references, as appropriate.
 - 12. Field dimensions and conditions, as appropriate.
 - 13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 - 14. Contractor's signature.
 - 15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
 - 1. Attachments shall be electronic files in PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
 - 1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 - 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
 - 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 5 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. Use software log that is part of web-based Project management software. Software log with not less than the following:
 - 1. Project name.
 - 2. Name and address of Contractor.
 - 3. Name and address of Architect.
 - 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.
 - 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
 - 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within three days if Contractor disagrees with response.

1.07 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Digital data files of Architect's Drawings will be provided by Architect for Contractor's use during construction.
 - 1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
 - 2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 - 3. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.
 - a. Subcontractors and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of Agreement acceptable to Owner and Architect].
 - 4. The following digital data files will be furnished for each appropriate discipline:

- a. Floor plans.
 - b. Reflected ceiling plans.
- B. Web-Based Project Management Software Package: Provide, administer, and use web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.
 - 1. Web-based Project management software includes, at a minimum, the following features:
 - a. Compilation of Project data, including Contractor, subcontractors, Architect, Architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
 - b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
 - c. Document workflow planning, allowing customization of workflow between project entities.
 - d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Track status of each Project communication in real time, and log time and date when responses are provided.
 - f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creating and distributing meeting minutes.
 - j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility, including smartphones and tablets.
 - 2. Provide up to ten Project management software user licenses for use of Owner, Owner's Commissioning Authority, Architect, and Architect's consultants. Provide software training at Architect's office for web-based Project software users.
 - 3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.
- C. 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.

1.08 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences virtually unless otherwise indicated.
 - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of seven days prior to meeting.
 - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 - 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
- B. Preconstruction Conference: 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, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Preparation of Record Documents.
 - o. Use of the premises and existing building.
 - p. Work restrictions.
 - q. Working hours.
 - r. Owner's occupancy requirements.
 - s. Responsibility for temporary facilities and controls.
 - t. Procedures for moisture and mold control.
 - u. Procedures for disruptions and shutdowns.
 - v. Construction waste management and recycling.
 - w. Parking availability.
 - x. Office, work, and storage areas.
 - y. Equipment deliveries and priorities.
 - z. First aid.
 - aa. Security.
 - bb. Progress cleaning.
 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Owner's Commissioning Authority of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. 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: 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, Owner's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.
 - i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

- E. Progress Meetings: Conduct progress meetings at weekly intervals or as agreed to by Architect and Owner.
1. Coordinate dates of meetings with preparation of payment requests.
 2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, 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.
 - a. Architect will be physically on site monthly as necessary and to review payment applications. Coordinate all Preinstallation, Mock-up, etc. meetings as necessary.
 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Progress cleaning.
 - 11) Quality and work standards.
 - 12) Status of correction of deficient items.
 - 13) Field observations.
 - 14) Status of RFIs.
 - 15) Status of Proposal Requests.
 - 16) Pending changes.
 - 17) Status of Change Orders.
 - 18) Pending claims and disputes.
 - 19) 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: Conduct Project coordination meetings 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, Owner's Commissioning Authority, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each contractor present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Resolution of BIM component conflicts.
 - 4) Status of submittals.
 - 5) Deliveries.
 - 6) Off-site fabrication.
 - 7) Access.
 - 8) Site use.
 - 9) Temporary facilities and controls.
 - 10) Work hours.
 - 11) Hazards and risks.
 - 12) Progress cleaning.
 - 13) Quality and work standards.
 - 14) Status of RFIs.
 - 15) Proposal Requests.
 - 16) Change Orders.
 - 17) Pending changes.
3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 PRODUCTS (NOT USED)**PART 3 EXECUTION (NOT USED)****END OF SECTION 01 3100**

**SECTION 01 3200
CONSTRUCTION PROGRESS DOCUMENTATION**

PART 1 GENERAL

1.01 SUMMARY

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

1.02 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine the critical path of Project and when activities can be performed.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.
- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of labor and equipment necessary for completing an activity as scheduled.

1.03 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file.
 - 2. PDF file.
- B. Startup construction schedule.

1. Submittal of cost-loaded startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.
- D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
- E. Construction Schedule Updating Reports: Submit with Applications for Payment.
- F. Daily Construction Reports: Submit at weekly intervals.
- G. Material Location Reports: Submit at weekly intervals.
- H. Site Condition Reports: Submit at time of discovery of differing conditions.
- I. Unusual Event Reports: Submit at time of unusual event.

1.04 QUALITY ASSURANCE

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

1.05 COORDINATION

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

1.06 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Computer Scheduling Software: Prepare schedules using current version of a program that is capable of managing construction schedules.
- B. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Final Completion.
 1. Contract completion date to not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
 - a. Securing of approvals and permits required for performance of the Work.
 - b. Temporary facilities.
 - c. Construction of mock-ups, prototypes and samples.
 - d. Owner interfaces and furnishing of items.
 - e. Interfaces with Separate Contracts.
 - f. Regulatory agency approvals.
 - g. Punch list.
 3. Procurement Activities: Include procurement process activities for long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 4. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 5. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 6. Commissioning Time: Include no fewer than 15 days for commissioning.
 7. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 8. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.
- D. 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. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 4. 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.
 5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.

- i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Building flush-out.
 - m. Startup and placement into final use and operation.
 - n. Commissioning.
6. 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.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion
- F. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
 1. See Section 012900 "Payment Procedures" for cost reporting and payment procedures.
- G. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and the Contract Time.
- H. 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.
- I. 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, equipment required to achieve compliance, and date by which recovery will be accomplished.
- J. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.07 REPORTS

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 3200

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**SECTION 01 3233
PHOTOGRAPHIC DOCUMENTATION**

PART 1 GENERAL

1.01 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.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Final completion construction photographs.
- B. Related Requirements:
 - 1. Section 02 0342 "Removal and Salvage of Period Construction Materials" and Section 02 4100 "Demolition: Selective Demolition of Non-historic Materials" for photographic documentation before selective demolition operations commence.

1.03 INFORMATIONAL SUBMITTALS

- A. Digital Photographs: Submit image files within 2 weeks of taking photographs.

1.04 USAGE RIGHTS

- A. Owner shall have usage rights for unlimited reproduction of photographic documentation.

PART 2 PRODUCTS

2.01 PHOTOGRAPHIC MEDIA

- A. Digital Camera: Minimum sensor resolution of 8 megapixels.
- B. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
- C. Digital Images: Provide images in JPG format exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- D. Identification: Provide the following information with each image description in file metadata tag: Date and time photograph was taken.

PART 3 EXECUTION

3.01 CONSTRUCTION PHOTOGRAPHS

- A. Engage a qualified person to take construction photographs.
- B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- C. Preconstruction Photographs: Before commencement of demolition, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points.
 - 1. Take photographs as necessary that clearly and completely show all existing conditions adjacent to building before starting the Work.
 - 2. Take photographs as necessary that clearly and completely show existing interior conditions to accurately record physical conditions of all work at start of construction.
 - 3. Take additional photographs as necessary to record settlement, delamination, cracking, etc., of adjacent existing structures, materials, pavements, improvements, etc.
- D. Final Completion Construction Photographs: Take photographs as necessary that clearly and completely show all work after date of Substantial Completion for submission as project record documents.

1. Do not include date stamp.

END OF SECTION 01 3233

**SECTION 01 3300
SUBMITTAL PROCEDURES**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021, with Errata (2023).

1.02 SUMMARY

- A. Section Includes:
 - 1. Submittal schedule requirements.
 - 2. Administrative and procedural requirements for submittals.

1.03 DEFINITIONS

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

1.04 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and 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. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
 - 3. 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 final release or approval.

1.05 SUBMITTAL FORMATS

- A. Submittal Information: Include the following information in each submittal:
 - 1. Project name.
 - 2. Date.
 - 3. Name of Architect.
 - 4. Name of Contractor.
 - 5. Name of firm or entity that prepared submittal.
 - 6. Names of subcontractor, manufacturer, and supplier.
 - 7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
 - 8. Category and type of submittal.
 - 9. Submittal purpose and description.

10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
 11. Drawing number and detail references, as appropriate.
 12. Indication of full or partial submittal.
 13. Location(s) where product is to be installed, as appropriate.
 14. Other necessary identification.
 15. Remarks.
 16. Signature of transmitter.
- B. Options: Identify options requiring selection by Architect.
- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect and Construction Manager on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

1.06 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 15 business days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block, and clearly indicate extent of revision.

3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.07 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrently with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.
- C. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
 1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.

- e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
- 3. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
- 4. 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.
- 5. 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 will return submittal with options selected.
- 6. 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 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.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 - 2. Manufacturer and product name, and model number if applicable.
 - 3. Number and name of room or space.
 - 4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
 - 1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed

- by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
 5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
 6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.
- H. Test and Research Reports:
1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
 2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
 3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
 4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
 5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
 6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.08 DELEGATED DESIGN SERVICES

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

designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
- C. BIM Incorporation: Incorporate delegated design drawing and data files into BIM established for Project.
1. Prepare delegated design drawings in the following format: Same digital data software program, version, and operating system as original Drawings.

1.09 CONTRACTOR'S REVIEW

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

1.10 ARCHITECT'S REVIEW

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 3300

**SECTION 01 4000
QUALITY REQUIREMENTS**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.
- B. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2023.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.03 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, 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.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).
- D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.
 - 1. Mockups are used for one or more of the following:
 - a. Verify selections made under Sample submittals.
 - b. Demonstrate aesthetic effects.
 - c. Demonstrate the qualities of products and workmanship.
 - d. Demonstrate successful installation of interfaces between components and systems.
 - e. Perform preconstruction testing to determine system performance.
 - 2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
 - 3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) in accordance with 29 CFR 1910.7, by a testing agency accredited in accordance with NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.04 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.05 CONFLICTING REQUIREMENTS

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

1.06 ACTION SUBMITTALS

- A. Mockup Shop Drawings:
 - 1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
 - 2. Indicate manufacturer and model number of individual components.
 - 3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.07 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel.

- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.08 CONTRACTOR'S QUALITY-CONTROL PLAN

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

inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.

- F. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.09 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, telephone number, and email address of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement of whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement of whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

- B. **Manufacturer Qualifications:** A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. **Fabricator Qualifications:** A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. **Specialists:** Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.
 - 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. **Testing and Inspecting Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. **Contractor's Responsibilities:**
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
 - e. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
 - 2. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups of size indicated.
 2. Build mockups in location indicated or, if not indicated, as directed by Architect.
 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 5. Demonstrate the proposed range of aesthetic effects and workmanship.
 6. Obtain Architect's approval of mockups before starting corresponding Work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 7. Promptly correct unsatisfactory conditions noted by Architect's preliminary review, to the satisfaction of the Architect, before completion of final mockup.
 8. Approval of mockups by the Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 10. Demolish and remove mockups when directed unless otherwise indicated.
- L. Specialty Mockups: See Section 014339 "Mockups" for additional construction requirements for integrated exterior mockups.

1.11 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 2. Payment for these services will be made from testing and inspection allowances specified in Section 012100 "Allowances," as authorized by Change Orders.
 3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for

construction that replaced Work that failed to comply with the Contract Documents.

- D. **Testing Agency Responsibilities:** Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform duties of Contractor.
- E. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- F. **Manufacturer's Technical Services:** Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- G. **Contractor's Associated Requirements and Services:** Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspection equipment at Project site.
- H. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.12 SPECIAL TESTS AND INSPECTIONS

- A. **Special Tests and Inspections:** Contractor will engage a qualified testing agency or special inspector to conduct special tests and inspections where required by authorities having jurisdiction as the responsibility of Owner, and as follows:
 - 1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 - 2. Notifying Architect and Owner promptly of irregularities and deficiencies observed in the Work during performance of its services.
 - 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.

4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections, and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected Work.

PART 2 PRODUCTS (NOT USED)**PART 3 EXECUTION****3.01 TEST AND INSPECTION LOG**

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

3.02 REPAIR AND PROTECTION

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

END OF SECTION 01 4000

**SECTION 01 4339
MOCKUPS**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.
- B. ASTM E699 - Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components; 2016.
- C. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015 (Reapproved 2023).

1.02 SUMMARY

- A. Section Includes:
 - 1. Window installation mock-up.
 - 2. Miscellaneous mockups listed in each product section.
- B. Related Requirements:
 - 1. Section 014000 "Quality Requirements" for quality assurance requirements for aesthetic and workmanship mockups specified in other Sections.

1.03 DEFINITIONS

- A. Window Mockups: Mockups of typical window installation complete with wall, floor, and ceiling finishes; windows; millwork; specialties; furnishings and equipment as indicated.

1.04 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, testing and inspecting agency representative, and installers of major systems whose Work is included in window mockups.
 - 2. Review coordination of equipment and furnishings provided by the Owner for room mockups.
 - 3. Review locations and extent of mockups.
 - 4. Review testing procedures to be performed on mockups.
 - 5. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups and testing and maintain schedule for the Work.

1.05 ACTION SUBMITTALS

- A. Shop Drawings: For window mockups.
 - 1. Include plans, elevations, sections, and mounting attachment and support details.
 - 2. Indicate manufacturer and model number of individual components, subassemblies, and assemblies.
 - 3. Include site location drawing indicating orientation of mockup.
 - 4. Revise and resubmit Shop Drawings to reflect approved modifications in details and component interfaces resulting from changes made during testing procedures.

1.06 INFORMATIONAL SUBMITTALS

- A. Window Mockup Coordination Drawings: drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
- B. Qualification Data: For testing agency.
- C. Preconstruction Test Reports: For integrated exterior mockups.

1.07 QUALITY ASSURANCE

- A. Preconstruction Laboratory Mockup Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated
- B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and acceptable to Owner and Architect.
- C. Build mockups to do the following:
 - 1. Verify selections made under Sample submittals.
 - 2. Demonstrate aesthetic effects.
 - 3. Demonstrate the qualities of products and workmanship.
 - 4. Demonstrate acceptable coordination between components and systems.
 - 5. Perform preconstruction testing, such as window air- and water-leakage testing.
- D. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the Work.
 - 1. Build mockups of size indicated.
 - 2. Build mockups in location indicated or, if not indicated, as directed by Architect.
 - 3. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
 - 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 6. Demolish and remove mockups when directed unless otherwise indicated.
- E. Notifications:
 - 1. Notify Architect seven days in advance of the dates and times when mockups will be constructed.
 - 2. Notify Architect 14 days in advance of the dates and times when mockups will be tested.
 - 3. Allow seven days for initial review and each re-review of each mockup.
- F. Approval: Obtain Architect's approval of mockups before starting fabrication or construction of corresponding Work.
 - 1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 COORDINATION

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

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design support structure for free-standing mockups.
- B. Mockup Testing Performance Requirements: Perform tests using design pressures and performance criteria indicated for assemblies and products that are specified in other Sections and incorporated into integrated exterior mockups.

2.02 WINDOW MOCKUPS

- A. Construct Window mockups according to Construction Drawings and approved mockup Shop Drawings. Construct mockups to demonstrate constructability, coordination of trades, and

sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.

- B. Build window mockups using installers and construction methods that will be used in completed construction.
- C. Use specified products that have been approved by Architect. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in window mockups.
- D. The Work of integrated exterior mockups includes, but is not limited to, items shown in Construction Drawings.
- E. Photographic Documentation: Document construction of integrated exterior mockups with photographs in accordance with Section 013233 "Photographic Documentation." Provide photographs showing details of interface of different materials and assemblies.
 - 1. Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.
- F. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Architect's approval for modifications.
- G. Retain approved mockups constructed in place. Incorporate fully into the Work.

PART 3 EXECUTION

3.01 TESTING OF WINDOW MOCKUPS

- A. Window Mockup Testing Agency: 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. Window Mockup Testing Services: Perform the following tests in the following order:
 - 1. Water-Spray Test: Before installation of interior finishes has begun, test areas designated by Architect in accordance with AAMA 501.2 for evidence of water penetration.
 - a. Perform a minimum of three tests in areas as directed by Architect.
 - 2. Water Penetration: Test in accordance with ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Mockup Testing Performance Requirements" Paragraph in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and verify no evidence of water penetration.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections, and also to observe testing for the following systems and assemblies.
- D. Window mockup will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 01 4339

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**SECTION 01 6000
PRODUCT REQUIREMENTS**

PART 1 GENERAL

1.01 SUMMARY

- A. The Work of This Section Includes: Administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for Contractor requirements related to Owner-furnished products.
 - 2. Section 012100 "Allowances" for products selected under an allowance.
 - 3. Section 012300 "Alternates" for products selected under an alternate.
 - 4. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 5. Section 014200 "References" for applicable industry standards for products specified.
 - 6. Section 017700 "Closeout Procedures" for submitting warranties.

1.02 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products unless otherwise indicated.
 - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
 - 1. Evaluating Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:

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

1.03 QUALITY ASSURANCE

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

1.04 COORDINATION

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

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

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

1.06 PRODUCT WARRANTIES

- A. Warranties specified in other Sections are to be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of Owner or endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of Owner or endorsed by manufacturer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 PRODUCTS

2.01 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

- a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by Architect, whose determination is final.
- B. Product Selection Procedures:
 1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
 2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
 3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
 4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
 - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
 5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.
 - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
 6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
 7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, provide the specified or indicated product or an approved equal product. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by another manufacturer.
 - a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.
- C. Visual Matching Specification: Where Specifications require the phrase "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or a similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.02 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with the following requirements:
 1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects, with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.
- B. Architect's Action on Comparable Products Submittal: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for a comparable product. Architect will notify Contractor of approval or rejection of proposed comparable product within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 1. Architect's Approval of Submittal: Marked with approval notation from Architect's action stamp. See Section 013300 "Submittal Procedures."
 2. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- C. Submittal Requirements, Two-Step Process: Approval by Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 6000

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**SECTION 01 7300
EXECUTION**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.02 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. Installation.
 - 3. Cutting and patching.
 - 4. Progress cleaning.
 - 5. Starting and adjusting.
 - 6. Protection of installed construction.
 - 7. Correction of the Work.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting surveys.
 - 2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
 - 3. Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.

1.03 DEFINITIONS

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

1.04 PREINSTALLATION MEETINGS

- A. Cutting and Patching Conference: Conduct conference at Project site.
 - 1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Inform Architect of scheduled meeting. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:
 - a. Contractor's superintendent.
 - b. Trade supervisor responsible for cutting operations.
 - c. Trade supervisor(s) responsible for patching of each type of substrate.
 - d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.
 - 2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.05 INFORMATIONAL SUBMITTALS

- A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 - 2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 - 3. Products: List products to be used for patching and firms or entities that will perform patching work.

4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.06 QUALITY ASSURANCE

- A. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."
- B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 1. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:
 - a. Primary operational systems and equipment.
 - b. Plumbing piping systems.
 - c. Mechanical systems piping and ducts.
 - d. Control systems.
 - e. Communication systems.
 - f. Fire-detection and -alarm systems.
 - g. Electrical wiring systems.
 - h. Operating systems of special construction.
 2. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
 - a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Exterior curtain-wall construction.
 - d. Sprayed fire-resistive material.
 - e. Equipment supports.
 - f. Piping, ductwork, vessels, and equipment.
 - g. Noise- and vibration-control elements and systems.
 3. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.

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

PART 3 EXECUTION

3.01 EXAMINATION

- A. Existing Conditions: The existence and location of construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems, and other construction affecting the Work.
- 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 mechanical and electrical systems to verify actual locations of connections before required work.
 - 2. Examine walls, floors, and ceilings for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - 1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. 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.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

3.03 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb, and make horizontal work level.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.
- D. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.

- E. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Architect. Fit exposed connections together to form hairline joints.

3.04 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 011000 "Summary."
- F. Existing Mechanical/Electrical Systems: Where existing systems are required to be revised, bypass such services/systems before cutting to minimize interruption to occupied areas.
- G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations using methods least likely to damage elements retained or adjoining construction.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots 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. 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.
 - 4. Proceed with patching after construction operations requiring cutting are complete.
- H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as

practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Walls: Where walls or partitions are revised, provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.05 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, in accordance with regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces in accordance with written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. 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.

- H. 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.
- I. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.06 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.

3.07 PROTECTION OF INSTALLED CONSTRUCTION

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

3.08 CORRECTION OF THE WORK

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

END OF SECTION 01 7300

**SECTION 01 7700
CLOSEOUT PROCEDURES**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. NADCA ACR - The NADCA Standard for Assessment, Cleaning, and Restoration of HVAC System; 2021.

1.02 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final Completion procedures.
 - 3. List of incomplete items.
 - 4. Submittal of Project warranties.
 - 5. Final cleaning.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
 - 2. Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.
 - 3. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 4. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.

1.03 DEFINITIONS

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

1.04 ACTION SUBMITTALS

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

1.05 CLOSEOUT SUBMITTALS

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

1.06 MAINTENANCE MATERIAL SUBMITTALS

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

1.07 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 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include

- occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number.
 5. Submit testing, adjusting, and balancing 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 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. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 6. Complete final cleaning requirements.
 7. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 2. Results of completed inspection will form the basis of requirements for Final Completion.

1.08 FINAL COMPLETION PROCEDURES

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

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.09 LIST OF INCOMPLETE ITEMS

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor, listed by room or space number.
 2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.
 4. Submit list of incomplete items in the following format:
 - a. Web-Based Project Software Upload: Utilize software feature for creating and updating list of incomplete items (punch list).

1.10 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 ???Insert number??? days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 1. Submit by uploading to web-based project software site.
- E. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.01 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

3.01 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site of rubbish, waste material, litter, and other foreign substances.

- b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Remove snow and ice to provide safe access to building.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.
 - i. Vacuum and mop concrete.
 - j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean in accordance with manufacturer's instructions if visible soil or stains remain.
 - k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - l. Remove labels that are not permanent.
 - m. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 - o. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

3.02 CORRECTION OF THE WORK

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

END OF SECTION 01 7700

**SECTION 01 7823
OPERATION AND MAINTENANCE DATA**

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.02 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.

1.03 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.
 - 2. Submit 1 paper format set of required documents.
- C. Initial Manual Submittal: Submit 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 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 days of receipt of Architect's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.04 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily

navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.05 PRODUCT MAINTENANCE MANUALS

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 7823

**SECTION 01 7839
PROJECT RECORD DOCUMENTS**

PART 1 GENERAL

1.01 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.

1.02 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 017700 "Closeout Procedures" for general closeout procedures.
 - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.03 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set of marked-up record prints.
 - 2. Number of Copies: Submit copies of Record Drawings as follows:
 - a. Final Submittal:
 - 1) Submit Record Digital Data Files and one set of plots.
 - 2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
- 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 indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.04 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Locations of concealed internal utilities.
 - d. Changes made by Change Order or Work Change Directive.
 - e. Changes made following Architect's written orders.
 - f. Details not on the original Contract Drawings.
 - g. Field records for variable and concealed conditions.
 - h. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Same digital data software program, version, and operating system as for the original Contract Drawings, and 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 for resolution.
 4. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 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
 - e. Name of Contractor.

1.05 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

1.06 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 3. Note related Change Orders and Record Drawings where applicable.
- C. 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.

1.07 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.

1.08 MAINTENANCE OF RECORD DOCUMENTS

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 01 7839

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**SECTION 02 0342
REMOVAL AND SALVAGE OF PERIOD CONSTRUCTION MATERIALS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work includes deconstruction and salvage of identified historic items and materials and removal of rubbish and debris.
- B. Specified procedures required for preservation treatment areas.
- C. Historic items and materials are indicated on drawings.

1.02 RELATED REQUIREMENTS

- A. Section 01 3591 - Period Treatment Procedures for general historic preservation project requirements.
- B. Section 02 4100 - Demolition: Selective demolition of nonhistoric, built site elements.

1.03 DEFINITIONS

- A. Debris: Nonhistoric building materials and contents destroyed during demolition.
- B. Deconstruction: Systematic dismantling and removal of a structure or its parts and salvage of elements and components for reuse, recycling, and retaining maximum value.

1.04 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Deconstruction Crew's Qualification Statement: Documentation of three consecutive years of work of this type, including similar projects identifying when, where, and for whom the work was performed.
- C. Work Plan: Detailed, proposed instructions for each type of operation of procedures for accomplishment of deconstruction work, including detailed description of the methods and equipment to be used and sequence of operations. Include the following:
 - 1. Extent of deconstruction, removal sequences, temporary bracing and shoring, and location and construction of barricades.
 - 2. Instructions for removal and disposition of period materials specified to be salvaged or recycled.
 - 3. Dust control measures.
 - 4. Protection of property to remain undisturbed.
 - 5. Ensure coordination with other work.
 - 6. Safe conduct of the work. Submit for information only.

1.06 QUALITY ASSURANCE

- A. Deconstruction Crew Qualifications: Workers trained and experienced in removal and salvage of historic materials.

1.07 FIELD CONDITIONS

- A. Comply with applicable requirements of NFPA 241.
- B. Protection of Existing Historic Property: Before beginning removal, salvage, or demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Take necessary precautions to avoid damage to existing items to remain in place, be reused, or remain Owner's property. Repair or restore to original condition items damaged by Contractor, using approved means, methods, and techniques. Replace items that cannot be successfully repaired or restored to original condition.

- C. Store materials to be salvaged or recycled daily, out of contact with the ground, under weathertight covering, in areas designated by Owner, and in the manner direct by Owner.
- D. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PERIOD TREATMENT, GENERAL

- A. See Section 01 3591 for special procedure requirements related to elements and features of historical significance and value.

3.02 GENERAL PROCEDURES

- A. Drawings indicating existing construction are based on casual field observation and existing record documents only.
 - 1. Verify that construction arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing historic elements.
 - 3. Beginning of work constitutes acceptance of existing conditions that are apparent upon examination at that time.
- B. See Section 02 4100 for selective demolition of nonhistoric elements.

3.03 ENVIRONMENTAL CONTROLS

- A. Comply with federal, state, and local regulations pertaining to water, air, solid waste, recycling, chemical waste, sanitary waste, sediment, and noise pollution.

3.04 ITEMS TO BE SALVAGED

- A. General: Salvage elements and components to the maximum extent possible. Maintain a chain of custody of salvaged materials, including the condition of such materials before and after salvage operations.
 - 1. Remove furnishings, equipment, and materials not scheduled for salvage or recycling prior to initiating salvaging procedures.
 - 2. Remove historic items to be salvaged from the structure prior to deconstruction work.
 - 3. Accomplish removal of salvageable items by hand labor to the maximum extent possible.
 - 4. Take care not to damage historic portions of the structure scheduled to remain or items identified for salvage.
- B. Metal Elements: Remove intact and salvage metal elements indicated on drawings.
- C. Wood Elements: Remove intact and salvage wood elements indicated on drawings.

3.05 MATERIALS TO BE REMOVED

- A. Remove existing nonhistoric elements as indicated and as required to allow direct access to period construction elements indicated to be restored or salvaged for reuse.
 - 1. Remove items indicated on drawings.
- B. Protect existing historic elements.
 - 1. Prevent movement of structure; provide temporary, removable shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly, minimizing overcutting.

3.06 CLEANING

- A. Upon completion of work, clean dust, dirt, and debris caused by salvage and demolition operations from portions of existing structure to remain and adjacent areas. Remove and transport debris and rubbish in a manner that prevents spillage on streets or adjacent areas. Obey local regulations regarding hauling and disposal.

**SECTION 02 4100
DEMOLITION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building demolition excluding removal of hazardous materials and toxic substances.
- B. Selective demolition of building elements for alteration purposes.

1.02 RELATED REQUIREMENTS

- A. Section 01 1000 - Summary: Limitations on Contractor's use of site and premises.
- B. Section 01 1000 - Summary: Description of items to be salvaged or removed for re-use by Contractor.
- C. Section 01 5000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- D. Section 01 6000 - Product Requirements: Handling and storage of items removed for salvage and relocation.
- E. Section 01 7000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

1.03 DEFINITIONS

- A. Demolition: Dismantle, raze, destroy or wreck any building or structure or any part thereof.
- B. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled.
- C. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and deliver salvaged items to Owner in ready-for-reuse condition.
- D. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.
- E. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.04 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
 - 1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.
 - 2. Demolition firm qualifications.
- C. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 DEMOLITION

- A. Remove items as indicated on drawings.
- B. Remove other items indicated, for salvage.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Provide, erect, and maintain temporary barriers and security devices.
 - 3. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 5. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Do not begin removal until built elements to be salvaged or relocated have been removed.
- D. Do not begin removal until vegetation to be relocated has been removed and vegetation to remain has been protected from damage.
- E. Protect existing structures and other elements to remain in place and not removed.
 - 1. Stop work immediately if adjacent structures appear to be in danger.
- F. Hazardous Materials:
 - 1. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.

3.03 EXISTING UTILITIES

- A. Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
 - 1. Verify construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Separate areas in which demolition is being conducted from areas that remain occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 5000 in locations indicated on drawings.
- C. Remove existing work as indicated and required to accomplish new work.

1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction indicated.
2. Remove items indicated on drawings.
- D. Services including, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications: Remove existing systems and equipment as indicated.
 1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.
 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 3. Verify that abandoned services serve only abandoned facilities before removal.
 4. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings. Remove back to source of supply where possible, otherwise cap stub and tag with identification.
- E. Protect existing work to remain.
 1. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 2. Repair adjacent construction and finishes damaged during removal work.

3.05 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 02 4100

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**SECTION 05 7300
DECORATIVE METAL RAILINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Railing systems.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. AISC 201 - AISC Certification Program for Structural Steel Fabricators, Standard for Steel Building Structures; 2006.
- C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- E. ASTM B138/B138M - Standard Specification for Manganese Bronze Rod, Bar, and Shapes; 2011 (Reapproved 2017).
- F. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings; 2021.
- G. ASTM E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings; 2024.
- H. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2023.
- I. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- J. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021, with Errata (2023).
- K. AWS C3.4M/C3.4 - Specification for Torch Brazing; 2016.
- L. AWS C3.5M/C3.5 - Specification for Induction Brazing; 2016, with Amendment (2017).
- M. AWS C3.9M/C3.9 - Specification for Resistance Brazing; 2020.
- N. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- O. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019.
- P. NAAMM AMP 500-06 - Metal Finishes Manual; 2006.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene preinstallation meeting one week before starting work of this section. Attendees include:
 - 1. Contractor.
 - 2. Manufacturer's representative.
 - 3. Architect.
 - 4. Owner's representative.
 - 5. Other subcontractors of adjacent work.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, including description of materials, components, finishes, fabrication details, glass, anchors, and accessories.
- B. Shop Drawings: Indicate railing system elevations and sections, details of profile, dimensions, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

Indicate anchor and joint locations, brazed connections, transitions, and terminations.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Samples: Submit one of each item below for each type and condition shown.
 1. Railing: 12-inch long section of each railing member, including top rails and posts; show color, finish, and connection details.
- D. Delegated Design Documents: Drawings and calculations sealed by Designer.
- E. Test Reports: Submit test reports from independent testing agency showing compliance with specified design and performance requirements.
- F. Manufacturer's Instructions: Indicate installation.
- G. Designer's qualification statement.
- H. Fabricator's qualification statement.
- I. Specimen warranty.
- J. Executed warranty.

1.05 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located or personnel under direct supervision of engineer.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.
- C. Fabricator Qualifications: Certified in accordance with AISC 201 and IAS AC172.
- D. Installer Qualifications:
 1. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
 2. Installation by manufacturer.
- E. Welder Qualifications: Welding processes and welding operators certified in accordance with AWS B2.1/B2.1M within 12 months of scheduled welding work.
- F. Templates: Supply installation templates, reinforcing, and required anchorage devices.

1.06 MOCK-UPS

- A. Provide mock-up of railing system, freestanding center rail, wall-mounted handrail, guardrail, and smoke baffle system, ____ feet long by ____ feet wide, indicating each type of material, cladding, and finish.
- B. Locate where directed.
- C. Mock-up may remain as part of work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in factory-provided protective coverings and packaging.
- B. Protect materials against damage during transit, delivery, storage, and installation at site.
- C. Inspect materials upon delivery for damage. Replace damaged items.
- D. Prior to installation, store materials and components under cover in dry location.

1.08 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard 1-year warranty against defects in materials, fabrication, finishes, and installation commencing on mm-dd-yyyy; complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Decorative Metal Railings:
 - 1. Julius Blum & Co., Inc.; www.juliusblum.com/.

2.02 RAILING SYSTEMS

- A. General: Factory- or shop-fabricated to suit project conditions, for proper connection to building structure, and in largest sizes practical for delivery to site.
- B. Performance Requirements:
 - 1. Comply with ASTM E985.
 - 2. Comply with ADA Standards.
 - 3. Structural Requirements: Design and fabricate railings and anchorages to resist loads without failure, damage, or permanent set.
 - a. Handrail and Top Rails: Applying loads simultaneously not required:
 - 1) Distributed Load: 50 lbf/ft minimum, applied horizontally and vertically at top of handrail.
 - 2) Concentrated Load: 200 lbf, minimum, when applied to handrail horizontally and vertically.
 - b. Infill:
 - 1) Concentrated Load: 50 lbf, minimum, when applied to infill horizontally and vertically.
- C. Performance Requirements: Applying loads simultaneously not required; design and fabricate railings and anchorages to resist loads without failure, damage, or permanent set, including:
 - 1. Lateral Force: 75 lb minimum, when tested in accordance with ASTM E935.
 - 2. Distributed Load: 50 lbf/ft minimum, applied vertically and horizontally at top of handrail, when tested in accordance with ASTM E935.
 - 3. Concentrated Loads: 200 lb minimum, applied to handrail horizontally and vertically, in accordance with ASTM E935.
- D. Assembly: Use slip-on, nonweld mechanical fittings, flanges, and escutcheons to join lengths, seal open ends, and conceal exposed mounting bolts and nuts.
- E. Joints: Machined smooth with hairline seams; tightly fitted and secured.
- F. Field Connections: Provide sleeves to accommodate site assembly and installation.
- G. Metal Railing: Engineered, post-supported railing system with metal infill.
 - 1. Configuration: Guardrail only.
 - 2. Top Rail: #4530, Julius Blum & Co., Inc..
 - 3. Decorative Flanges for Embedded Posts: #297, Julius Blum & Co., Inc..
 - 4. Fasteners: Exposed.
 - 5. Infill at Picket Railings: Vertical pickets.
 - a. Horizontal Spacing: Maximum 4 inches on center.
 - b. Material: Bronze.
 - c. Shape: Square.
 - d. Size: 5/8-inch square.
 - e. Top Mounting: Mechanically attached by internal fittings.
 - f. Bottom Mounting: As indicated on drawings.
 - 6. End and Intermediate Posts: As shown on drawings.
 - a. Mounting: Welded.

2.03 MATERIALS

- A. Bronze Components: ASTM B138/B138M.
 - 1. Concealed: Alloy 280 muntz metal; color similar to alloy 385.
 - 2. Exposed: Architectural extruded bronze; color similar to alloy 280.

2.04 FABRICATION

- A. Welded and Brazed Joints: Make visible joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish; grind smooth, polish, and restore to required finish.
 - 1. Ease exposed edges to small uniform radius.
 - 2. Welded Joints:
 - 3. Brass and Bronze Brazed Joints:
 - a. Perform torch brazing in accordance with AWS C3.4M/C3.4.
 - b. Perform induction brazing in accordance with AWS C3.5M/C 3.5.
 - c. Perform resistance brazing in accordance with AWS C3.9M/C3.9.

2.05 FINISHES

- A. General: Comply with NAAMM AMP 500-06.
 - 1. Complete mechanical finishes before fabrication. After fabrication, finish joints, bends, abrasions, and surface blemishes to match sheet.
 - 2. Protect mechanical finishes on exposed surfaces from damage.
 - 3. Apply organic and anodic finishes to formed metal after fabrication.
 - 4. Appearance: Limit variations in appearance of adjacent pieces to one-half of range represented in approved samples. Noticeable variations in same piece are not acceptable. Install components within range of approved samples to minimize contrast.
- B. Bronze Finish: US9 - Bright Bronze finish.
 - 1. Protective Coating: Acrylic-based coating, clear lacquer.

2.06 ACCESSORIES

- A. Welding Fittings: Factory- or shop-welded from matching pipe or tube; joints and seams ground smooth.
- B. Anchors and Fasteners: Provide anchors, fasteners, and other attachment devices required to attach to structure.
 - 1. Provide attachment devices of same material as components.
 - 2. Steel Fasteners: ASTM F3125/F3125M, Type 1, galvanized in accordance with ASTM A153/A153M.
 - 3. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing; provide only where exposed fasteners are unavoidable.
- C. Finish Touch-Up Materials: As recommended by manufacturer for field application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate and site conditions are acceptable and ready to receive work.
- B. Verify field dimensions of locations and areas to receive work.
- C. Notify Architect immediately of conditions that would prevent satisfactory installation.
- D. Do not proceed with work until detrimental conditions are corrected.

3.02 PREPARATION

- A. Protection of In-Place Conditions: Protect existing work before proceeding with installation.
- B. Review installation drawings before beginning installation. Coordinate diagrams, templates, instructions, and directions for installation of anchorages and fasteners.
- C. Clean surfaces to receive railings. Remove materials and substances detrimental to installation.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, and with tight joints, except where necessary for expansion.

- C. Anchor securely to structure.
- D. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- E. Weld connections that cannot be shop welded due to size limitations.
 - 1. Weld in accordance with AWS D1.1/D1.1M.
 - 2. Match shop welding and bolting.
 - 3. Clean welds, bolted connections, and abraded areas.
 - 4. Touch up shop primer and factory-applied finishes.
 - 5. Repair galvanizing with galvanizing repair paint in accordance with ASTM A780/A780M.
- F. Isolate dissimilar materials with bituminous coating, bushings, grommets, or washers to prevent electrolytic corrosion.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per floor level, noncumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Test railings for structural performance in accordance with ASTM E935.
- C. Nonconforming Work: Repair nonconforming work and retest until work complies with specified requirements.
- D. Manufacturer Services: Provide services of manufacturer's field representative to observe railing installation.

3.06 CLEANING

- A. Remove protective film from exposed metal surfaces.
- B. Metal: Clean exposed metal finishes with potable water and mild detergent in accordance with manufacturer recommendations; do not use abrasive materials or chemicals, detergents, or other substances that may damage material or finish.

3.07 PROTECTION

- A. Protect installed components and finishes from damage after installation.
- B. Repair damage to exposed, making finishes indistinguishable from undamaged areas.
- C. Replace finishes and components that have irreparable damage. Ensure damaged areas are indistinguishable from undamaged finishes and surfaces.

END OF SECTION 05 7300

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**SECTION 06 2000
FINISH CARPENTRY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wood casings and moldings.

1.02 RELATED REQUIREMENTS

- A. Section 09 9300 - Staining and Transparent Finishing: Staining and transparent finishing of finish carpentry items.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide manufacturer's product data, storage and handling instructions for factory-fabricated units.
- C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- D. Samples: Submit two samples of wood trim 18 inch long.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store finish carpentry items under cover, elevated above grade, and in a dry, well-ventilated area not exposed to heat or sunlight.
- B. Protect from moisture damage.
- C. Handle materials and products to prevent damage to edges, ends, or surfaces.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Interior Woodwork Items:
 - 1. Moldings: Clear white oak; prepare for stain finish.

2.02 FASTENINGS

- A. Fasteners: Of size and type to suit application; _____ finish in concealed locations and _____ finish in exposed locations.

2.03 SITE FINISHING MATERIALS

- A. Field Finishing: See Section 09 9300.

2.04 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.

- B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION

- A. Install custom fabrications in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.

3.03 PREPARATION FOR SITE FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
- B. Site Finishing: See Section 09 9113, 09 9123, and 09 9300.
- C. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.04 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch.
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

END OF SECTION 06 2000

**SECTION 06 2614
MINERAL PROFILE PANELING**

GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.
- B. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer; 2016.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- D. GA-214 - Levels of Finish for Gypsum Panel Products; 2021.

1.02 SUMMARY

- A. Section Includes: Composite mineral profile paneling and seam finishing materials to create a monolithic sculptured wall surface.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ASTM American Society for Testing and Materials.
 - 2. GA Gypsum Association.
- B. Reference Standards:
 - 1. ASTM D256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 - 2. ASTM D696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer.
 - 3. ASTM E84 Standard Test Methods for Surface Burning Characteristics of Building Materials.
 - 4. GA-214 Recommended Levels of Gypsum Board Finish.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meetings:
 - 1. Convene meeting at project site within one week of scheduled start of installation with representatives of the following in attendance: Owner, Architect, General Contractor, Installer, Finisher, and Painter.

1.05 REVIEW SUBSTRATE CONDITIONS, REQUIREMENTS OF RELATED WORK, INSTALLATION INSTRUCTIONS, SEAM FINISHING, AND PAINTING INSTRUCTIONS, STORAGE AND HANDLING PROCEDURES, AND PROTECTION MEASURES.

- 1. Keep minutes of meeting including responsibilities of various parties and deviations from specifications and installation instructions.

1.06 ACTION SUBMITTALS

- A. Product Data: Each product specified.
- B. Project List: Minimum 5 previous completed ModularArts, Inc. installations or 5 installations of similar materials and complexity. Include contact name and e-mail address or telephone number for each project.
- C. Shop Drawings: Show standard and project specific details including termination at adjacent surfaces.
- D. Samples: Minimum 15 by 15 inch panel of specified design(s).

1.07 INFORMATIONAL SUBMITTALS

- A. Manufacturer's installation instructions.
- B. Regulatory agency sustainability submittals:

- C. Qualification Statements: Proof of manufacturer, installer, and finisher qualifications.

1.08 QUALITY ASSURANCE

- A. Qualifications:
1. Manufacturer: Minimum five years' experience in producing mineral profile paneling.
 2. Installer: Minimum three years' experience in finish carpentry/architectural woodwork installation.
 3. Finisher: Minimum three years' experience in executing Level 5 finish in accordance with GA-214.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Handling Requirements:
1. Store panels in fully enclosed environmentally controlled space, protected against damage from moisture, direct sunlight, extreme temperatures, and surface contamination.
 2. Store panels vertically, in shipping crates, until ready to be installed. Loosen crate lids to allow for venting. Do not stack or lean against walls.
 3. Store panels in area of installation minimum 24 hours prior to installation.
- B. Packaging Waste Management: 100 percent of materials used to package components of this section shall be recyclable.

1.10 FIELD CONDITIONS

- A. Ambient Conditions:
1. HVAC: Operate HVAC system to maintain occupancy level temperature and relative humidity conditions (35 to 67 percent) in the area of installation from 24 hours prior to delivery of panels to the installation area through remainder of construction period.
 2. Lighting: Permanent project lighting, including any special lighting used to highlight the profiled panels, must be operational prior to seam finishing.

1.11 WARRANTY

- A. Manufacturer Warranty: Provide manufacturer's standard limited warranty.

PRODUCTS

2.01 BASIS OF DESIGN

- A. Provide Basis of Design or approved equal product.
- B. Basis of Design is the Stella Mineral Profile panel as offered by Modular Arts, Inc. of Kent WA
- C. Tel: 206.788.4210 info@modularArts.com Website: www.modularArts.com

2.02 COMPONENTS

- A. Profile Panel: Glass reinforced gypsum (GRG) casting with light-weight gypsum core.
1. Size: 32 x 32 x 1 to 2" inch maximum panel thickness depending on design.
 2. Physical Properties:

a. Izod Impact Strength: ASTM D 256	9.4 ft-lb/in ²
b. Thermal Expansion: ASTM D 696	3.8x10 ⁻⁷ in/in °F
c. Compressive Strength: ASTM D 696	2.3 ksi
d. Flame Spread Index: ASTM E 84	0
e. Smoke Development Index: ASTM E 84	0
f. Weight (for all design excluding MUDD formerly YUMA)	2.7 psf
g. Weight (for MUDD design only)	3.9 psf
 3. Design: Stella; refer to the construction drawings for direction of panel installation.

2.03 ACCESSORIES

- A. Anchors: 30 lb. self-drilling, drywall anchor.

- B. Screws: Coarse thread, drywall type, length as required by panel design and in accordance with Manufacturer's Installation Instructions.

2.04 SOURCE QUALITY CONTROL

- A. Fabrication Tolerances:
 - 1. Dimensions, length and width: $\pm 1/16$ inch.
 - 2. Thickness: $\pm 1/16$ inch.
 - 3. Weight: $\pm 1/2$ lb.

EXECUTION

3.01 EXAMINATION

- A. Examine substrates upon which profile paneling will be installed.
 - 1. Verify that substrate is a material listed as an acceptable substrate by the profile paneling manufacturer.
- B. Verify that permanent project lighting is in place and operational prior to start of seam finishing.
- C. Coordinate with responsible entity to correct unsatisfactory conditions.
- D. Commencement of work by installer is acceptance of substrate conditions.

3.02 INSTALLATION

- A. Install profile paneling in accordance with Manufacturer's written Installation Instructions Sand and finish seams, seal and apply paint per finish schedule.

3.03 CLEANING AND PROTECTION

- A. Protect finished work from damage during remainder of construction period.

END OF SECTION 06 2614

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**SECTION 07 9219
ACOUSTICAL JOINT SEALANTS**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2022.
- C. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).
- D. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.

1.02 SUMMARY

- A. Section Includes: Acoustical joint sealants.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants, showing full range of available colors for each product exposed to view.
- C. Samples for Verification: For each type and color of acoustical joint sealant required.
 - 1. Size: 1/2-inch- (13-mm-) wide sealant joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Acoustical 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.

1.04 INFORMATIONAL SUBMITTALS

- A. Test and Evaluation Reports:
 - 1. Product Test Reports: For each type of acoustical joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- B. Sample warranties.

1.05 CLOSEOUT SUBMITTALS

- A. Warranty Documentation:
 - 1. Manufacturers' special warranties.
 - 2. Installer's special warranties.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained between 40 and 95 deg F (4 and 35 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.07 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 60 and 90 deg F. Warm surfaces to be coated to be a minimum of 70 deg F to enhance drying.

1.08 WARRANTY

- A. Installer's Special Warranty: Installer agrees to repair or replace acoustical 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. Manufacturer's Special Warranty: Manufacturer agrees to furnish acoustical 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: ten years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 ACOUSTICAL JOINT SEALANTS

- A. Acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies in accordance with ASTM E90.
- B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

2.02 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by acoustical joint-sealant manufacturer where required for adhesion of sealant to joint 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

3.01 EXAMINATION

- A. Examine joints indicated to receive acoustical 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.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where recommended by acoustical joint-sealant manufacturer. 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.

3.03 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

- A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.
- B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written instructions for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.
- C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings

before they are installed.

3.04 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 acoustical joint sealants and of products in which joints occur.

3.05 PROTECTION

- A. Protect acoustical 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 acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 9219

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**SECTION 09 2116
GYPSUM BOARD ASSEMBLIES**

PART 2 PRODUCTS

1.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

1.02 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum Company; ____: www.americangypsum.com/#sle.
 - 2. CertainTeed Corporation; ____: www.certainteed.com/#sle.
 - 3. Georgia-Pacific Gypsum; ____: www.gpgypsum.com/#sle.
 - 4. Gold Bond Building Products, LLC provided by National Gypsum Company; ____: www.goldbondbuilding.com/#sle.
 - 5. PABCO Gypsum; ____: www.pabco gypsum.com/#sle.
 - 6. USG Corporation; ____: www.usg.com/#sle.
 - 7. Substitutions: See Section 01 6000 - Product Requirements.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 1/2 inch.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.

1.03 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness 2 inches.
- B. Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
 - 1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 2. Tape Thickness: 1/4 inch.
- C. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- D. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
 - 1. Corner Beads: Low profile, for 90 degree outside corners.
 - 2. L-Trim with Tear-Away Strip: Sized to fit 1/2-inch thick gypsum wallboard.
 - 3. Expansion Joints:
- E. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Paper Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 - 2. Joint Compound: Drying type, vinyl-based, ready-mixed.
- F. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.

PART 3 EXECUTION

2.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

2.02 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.
- C. Acoustic Sealant: Install in accordance with manufacturer's instructions.
 - 1. Place one bead continuously on substrate before installation of perimeter framing members.
 - 2. Place continuous bead at perimeter of each layer of gypsum board.
 - 3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.

2.03 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
 - 1. Exception: Tapered edges to receive joint treatment at right angles to framing.
- C. Double-Layer, Nonrated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- D. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.

2.04 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.

2.05 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.

2.06 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION 09 2116

**SECTION 09 2216
NON-STRUCTURAL METAL FRAMING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal partition, ceiling, and soffit framing.
- B. Framing accessories.

1.02 RELATED REQUIREMENTS

- A. Section 09 2116 - Gypsum Board Assemblies: Metal studs for gypsum board partition framing.
- B. Section 09 8300 - Acoustic Plaster Finishes: Metal furring for acoustic plaster finish framing.

1.03 REFERENCE STANDARDS

- A. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- C. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- E. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- F. ASTM E413 - Classification for Rating Sound Insulation; 2022.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate prefabricated work, component details, stud layout, framed openings, anchorage to structure, acoustic details, type and location of fasteners, accessories, and items of other related work.
 - 2. Describe method for securing studs to tracks, splicing, and for blocking and reinforcement of framing connections.
- C. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience and approved by manufacturer.
- B. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Framing, Connectors, and Accessories:
 - 1. CEMCO; ____: www.cemcosteel.com/#sle.
 - 2. ClarkDietrich; ____: www.clarkdietrich.com/#sle.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FRAMING MATERIALS

- A. Non-Loadbearing Framing System Components: AISI S220; sheet steel, of size and properties necessary for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
 - 1. Studs: C-shaped with flat faces.

2. Studs: C-shaped with triangular-shaped, lipped holes.
 3. Runners: U-shaped, sized to match studs.
 4. Ceiling Channels: C-shaped.
 5. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
- B. Partition Head to Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and braced with continuous bridging on both sides.
- C. Non-Loadbearing Framing Accessories:
1. Fasteners: ASTM C1002 self-piercing self-tapping screws.
 2. Anchorage Devices: Drilled expansion bolts.
 3. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness as required for STC.
 4. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- D. Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 2. Tape Thickness: 1/4 inch.

2.03 FABRICATION

- A. Fabricate assemblies of framed sections to sizes and profiles required.
- B. Fit, reinforce, and brace framing members to suit design requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that rough-in utilities are in proper location.

3.02 INSTALLATION OF STUD FRAMING

- A. Extend partition framing to structure where indicated and to ceiling in other locations.
- B. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
- C. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs as indicated.
- D. Align and secure top and bottom runners at 24 inches on center.
- E. At partitions indicated with an acoustic rating:
 1. Provide components and install as required to produce STC rating of ____, based on published tests by manufacturer conducted in accordance with ASTM E90 with STC rating calculated in accordance with ASTM E413.
 2. Place one bead of acoustic sealant between runners and substrate, studs and adjacent construction.
 3. Place one bead of acoustic sealant between studs and adjacent vertical surfaces.
 4. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.
- F. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.
- G. Install studs vertically at 16 inches on center.
- H. Align stud web openings horizontally.
- I. Secure studs to tracks using crimping method. Do not weld.

- J. Stud splicing is not permissible.
- K. Fabricate corners using a minimum of three studs.
- L. Install double studs at wall openings, door and window jambs, not more than 2 inches from each side of openings.
- M. Coordinate erection of studs with requirements of door frames and window frames; install supports and attachments.
- N. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.
- O. Furring: Install at spacing and locations shown on drawings. Lap splices a minimum of 6 inches.

3.03 CEILING AND SOFFIT FRAMING

- A. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.
- B. Install furring independent of walls, columns, and above-ceiling work.
- C. Securely anchor hangers to structural members or embed them in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.
- D. Space main carrying channels at maximum 72 inches on center, and not more than 6 inches from wall surfaces. Lap splice securely.
- E. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.
- F. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.
- G. Reinforce openings in suspension system that interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 24 inches past each opening.
- H. Laterally brace suspension system.

3.04 TOLERANCES

- A. Maximum Variation From True Position: 1/8 inch in 10 feet.
- B. Maximum Variation From Plumb: 1/8 inch in 10 feet.

END OF SECTION 09 2216

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**SECTION 09 6513
RESILIENT BASE AND ACCESSORIES**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- B. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Vinyl base and accessories

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

1.05 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. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products 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).

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products 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 or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.01 VINYL BASE

- A. Provide Basis of Design or approved equal product
- B. Basis of Design is .080" Type TV Traditional Vinyl Base as offered by Johnsonite through Tarkett

1. Color as selected by Architect from manufacturers full line of standard and premium colors.
- C. Product Standard: ASTM F1861, Type TV (vinyl, thermoplastic).
 1. Group: I (solid, homogeneous).
 2. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient floor.
- D. Minimum Thickness: 0.080 inch.
- E. Height: 4 inches unless otherwise indicated in Drawings.
- F. Corners: Job formed or preformed.

2.02 VINYL MOLDING ACCESSORY

- A. Description: Vinyl transition strips as required.

2.03 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Basis of Design is Johnsonite 960 Wall base adhesive or approved equal product.

PART 3 EXECUTION

3.01 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 products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by 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 10 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.
- 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 products until materials are the same temperature as space where they are to be installed.
 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

3.04 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.05 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 09 6513

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**SECTION 09 8300
ACOUSTIC PLASTER FINISHES**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes seamless sound absorptive acoustical plaster system.
- B. Related Sections include the following:
 - 1. Section 09 2216 - Non-Structural Metal Framing

1.03 DEFINITIONS

- A. LR: Light-Reflectance coefficient.
- B. NRC: Noise Reduction Coefficient.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings, showing the following:
 - 1. Base Drawings, Approved Detail Drawings and Field Measurements.
 - 2. Show dimensioned ceiling plans with joint locations, mounting details, transitions details to adjacent work, design, weight, thickness, color and other data necessary to install the work and coordinate work with other affected trades.
- C. Samples for Verification: Provide minimum 12-inch by 12-inch sample of acoustical finish system in color(s) indicated.
- D. Test Reports from an independent acoustical laboratory demonstrating compliance with acoustical performance requirements below.

1.05 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Acoustical Plaster Walls: Obtain all components of acoustical finish system from one manufacturer, unless recommended otherwise by system manufacturer.
- B. Installer Qualifications: Installer shall be certified to install acoustical plaster by manufacturer and shall have at least 3 years experience installing similar products, employing supervisors and mechanics certified and approved by the manufacturer.
- C. Fire-Test-Response Characteristics: Provide acoustical plaster ceilings that comply with the following requirements:
 - 1. Surface-burning characteristics of acoustical panels comply with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84.
- D. Acoustical Performance Data:
 - 1. Certified Acoustical Performance Sound Absorption Test Report data, shall meet the following minimum requirements. Noise Reduction Coefficient (NRC) for the 1.18-inch system shall not be less than 0.85 per ASTM C 423-07 "Standard Test Method for Sound Absorption and sound Absorption Coefficients by the Reverberation Room Method".
- E. Fire Test Data:
 - 1. Certified Reports on Surface Burning Characteristics Determined by ASTM E 84 conducted by a recognized, independent, testing agency, shall be submitted upon request and meet the following minimum requirements:
 - a. Class A Flame Spread Classification:
 - 1) 0 – 15 Flame Spread
 - 2) 0 – 15 Smoke Development

- F. Compressive strength: Maximum 125 PSI per ASTM E736
- G. Transmission Loss rating shall not be less than STC 28 per ASTM E-90. Provide support test data from independent test lab.
- H. Light Reflectance Coefficient Test Data: Certified Reports on Light Reflectance Coefficient Performance Determined by ASTM E 1477-98, conducted by a recognized, independent, testing agency, shall be submitted upon request and meet the following minimum requirements:
 - 1. Light Reflectance Value "L" a minimum of 91 or Value "Y" a minimum of 74.

1.06 MOCKUPS

- A. Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Provide minimum 5-feet by 5-feet mock-up of the sound absorptive finish systems, including substrates (or metal framing in lieu of substrate if per system), replicating relative details and conditions.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Completion.
- B. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Allow materials to become acclimated to Project conditions before installation.
- B. Ship and deliver in protective packaging to prevent freight damage.
- C. Store materials in accordance with manufacturer's recommendations in a fully enclosed space where materials will be protected against damage from moisture, direct sunlight, surface contamination and other causes. All wet work must be completed in area of storage.
- D. Protect acoustical plaster materials from freezing.

1.08 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with requirements of referenced plaster application standards and recommendations of product manufacturer for environmental conditions before, during and after installation.
- B. Cold Weather Requirements: When ambient outdoor temperatures are below 40 degrees Fahrenheit, maintain a continuous uniform temperature of at least 50 degrees Fahrenheit for at least 3 days before beginning of the material application, during its application and until material is dry, but for at least 7 days after application is complete. Distribute heat evenly; prevent concentrated or uneven heat from contacting material application near heat source.
- C. Ventilation: Ventilate building spaces as required to remove excess moisture to promote drying of applied material. Dehumidification required if humidity exceeds 75%.
- D. Protect contiguous work from soiling, splattering, moisture deterioration and other harmful effects that may be caused by the application of the material.

PART 2 PRODUCTS

2.01 ACOUSTICAL PLASTER (APL1)

- A. Manufacturer: Subject to compliance with requirements, provide one of the following:
 - 1. Sound Absorptive Acoustical Finish System StarSilent by Pyrok, Inc. (Basis-of-Design)
- B. Basis-of-Design System Description: The Seamless Sound Absorption System shall consist of a sound absorbing panel made of recycled glass screwed into a rigid framing system. A base coat and a finish coat shall be applied onto the supporting panels on site, per manufacturer's specifications. The top coat shall be troweled smooth to give the appearance of a smooth conventional plaster.
- C. The Acoustical Plaster System shall consist of StarSilent sound absorbing, StarSilent Fix, Base coat and Finish Coat Plasters.

- D. Plaster System shall be provided in a total system thickness (Sound Panels, Base and Top Finish Coat) of approximately 1.18-inches.
- E. The Base and Top Finish coat shall be provided in the standard Pyrok, StarSilent "natural white" color, or equal.
- F. Provide manufacturer's standard trim as required for a complete installation.
- G. Access doors used in the acoustical plaster system shall be "trimless" and have a 1-inch recessed door. Access Door model number 5020, sized as required, manufactured by Karp, Inc. or equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas where and conditions under which acoustical plaster is to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected to permit the proper installation of the work.
- B. All substrates (or metal framing if per system) for the application shall not vary from plumb, level or "smooth consistent curvature" more than 1/4 inch in 12 feet.
- C. All HVAC, electrical, fire sprinkler and other penetrations of the substrate shall be sealed with traditional drywall tape or a self-adhesive fire tape to prevent air movement between the plenum and finished space or vice versa.
- D. All acoustical plaster systems shall be installed over a rigid framing system. All penetrations shall be "closed off" to prevent air from passing through the acoustical plaster, thereafter through the substrate and then into the plenum above, or vice versa.
- E. Verify that all mechanical and electrical services within the area of application have been roughed in at the appropriate depth relative to the thickness of the system; tested and approved, prior to commencement of application. Review approved details provided by manufacturer for verification.

3.02 PREPARATION

- A. Substrate materials:
 - 1. All plaster systems shall be installed over a "sealed air tight" substrate. All penetrations shall be "closed off" to prevent air from passing through the acoustical plaster, thereafter through the substrate and then into the plenum above, or vice versa.
 - 2. All HVAC, electrical, fire sprinkler and other penetrations of the substrate shall be sealed with traditional drywall tape or a self-adhesive fire tape to prevent air movement between the plenum and finished space or vice versa.
 - 3. Adhesive strength required for bonding to the substrate surface for the application of the plaster system is a minimum of 17 N/psf.
 - 4. Plywood substrates are not acceptable due to the potential of excessive expansion and contraction movement.
 - 5. All substrates for the application shall not vary from plumb, level, or a "smooth consistent curvature" by more than 1/4 inch in 12 feet.

3.03 INSTALLATION

- A. Install materials in accordance with the manufacturer's installation instructions and details. Installation shall start only after all other work in the area of the installation has been completed. Basis-of-Design system shall be installed as follows:
 - 1. Recycled glass sound absorbing panels (25mm) screwed to framing with stainless steel drywall screws.
 - 2. Trim: Install white vinyl trim pieces with approved adhesives.
 - 3. StarSilent Fix: Glue panels together and spot screw heads with Starsilent Fix.
 - 4. Base Coat: Prior to applying the layer of base coat, ensure product is thoroughly mixed and several pails are continuously batched together in order to provide even consistent

coloring. Apply a 1.0 - 2.0mm thick layer and trowel smooth. Sand smooth when completely dry.

5. Top Coat: Prior to applying the layer of acoustical plaster system top coat, ensure product is thoroughly mixed and several pails are continuously batched together in order to provide even consistent coloring. Apply a 0.5 - 1.0mm thick layer of acoustical plaster system top coat and trowel smooth to a quality level consistent with accepted samples or mockup. Note that acoustical plaster system is a hand troweled finished product. Inherent in all hand troweled product applications, minor acceptable trowel marks and other imperfections in the finished surface may occur which are only visible at certain times of day or under certain critical lighting conditions. The finish should be critically viewed only under end-use lighting conditions.

B. Installation requirements:

1. Hand Tools: All application of acoustical plaster system pre-coated mineral wool panels, fill, base and top coats must be facilitated by using the proper acoustical plaster system stainless steel flat or notched hand trowels supplied by manufacturer of acoustical plaster system. The proper notched gauging trowels and smoothing trowels shall be used at each step noted below in order to control material thickness.
2. Lighting: Inherent in all hand-troweled product applications, minor acceptable trowel marks in the finished surface may occur and become exposed or "exaggerated" under critical lighting. Ensure that the lighting used during the entire installation process replicates the actual finished lighting. All skylights, clearstory windows and other openings which naturally light the area of the installation shall be uncovered during the entire installation in order to represent finished conditions.
3. Drying Times: Drying times when installing the acoustical plaster system panel adhesive, fill, base and top coats are typically overnight, however, drying times may be longer due to unusual on-site conditions. Prior to proceeding with any additional work, ensure acoustical plaster system panel, base top coat is completely and thoroughly dry.
4. Finished Coat Installation: Application of the acoustical plaster system top coat shall be facilitated in one operation at each area of installation; "cold joints" in the Top coat are not acceptable.
5. Staging: Generally, the acoustical plaster system is installed using full "tiered scaffolding with outriggers" on wall applications and/or a full "dance floor scaffolding" on ceiling applications in order to achieve an acceptable finish without "cold joints". Rolling tower scaffolds which can be moved across an installation area are acceptable.
6. Access Doors in Acoustical Plaster System: Install per detail approved by acoustical plaster system manufacturer.
7. Securing to Acoustical Plaster System: Light fixtures, ornamentation, speakers, cover plates or any other items cannot be attached to the acoustical plaster system. Ensure items are secured to proper blocking or other attachment system independent of the acoustical plaster system per details approved by acoustical plaster system manufacturer.

3.04 CLEANING

- A. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

END OF SECTION 09 8300

**SECTION 09 8433
SOUND-ABSORBING WALL UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sound-absorbing panels.
- B. Mounting accessories.

1.02 SUMMARY

- A. Section includes shop-fabricated, sound-absorbing acoustical panel units tested for acoustical performance.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Independent testing agency test reports.
- B. Shop Drawings: For unit assembly and installation.
- C. Samples: For each exposed product and for each color and texture specified.
 - 1. Provide two samples, minimum size 6 inches square representing actual product, color, and pattern.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
- B. Product certificates.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 10 years of experience in producing acoustical products.
- B. Installer Qualifications: Acceptable to the manufacturer of the acoustical products being installed.
- C. Mock-Up: Provide a mock-up for evaluation of installed appearance.
 - 1. Install acoustical products in areas designated by Architect.
 - 2. Do not proceed with remaining work until Architect approves workmanship and appearance.
 - 3. Approved mock-up may remain as part of the work.
- D. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:
 - 1. Thickness.
 - 2. Edge straightness.
 - 3. Overall length and width.
 - 4. Squareness from corner to corner.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect acoustical products during shipment, storage, and handling.
- B. Store products in manufacturer's unopened packaging until ready for installation.
 - 1. Store materials flat.
 - 2. Do not stand panels on end.
 - 3. Protect edges from damage.

1.08 PROJECT CONDITIONS

- A. Do not begin installation of acoustical products until building has been enclosed and environmental conditions approximate those that will prevail when building is occupied.
- B. Environmental Requirements: Do not install panels until wet work, such as concrete and plastering, is complete; the building is enclosed; and walls are primed.

1.09 EXTRA MATERIALS

- A. Provide 5 percent, but not less than 1 of each type of acoustical unit actually installed, for Owner's use in maintenance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide products equal to those listed below from: G&S Acoustics; 3555 Scarlet Oak Blvd., St. Louis, MO 63122. ASD. Tel: (636) 225-8800 or (800) 737-0307. Fax: (636) 225-2966. Email: inquiry@gsacoustics.com. www.gsacoustics.com.
- B. Substitutions: Products shall be exactly equal to those listed below. Requests for substitutions shall only be considered in accordance with provisions of Section 01 2500 - Substitution Procedures.
- C. Provide all acoustical products specified herein by a single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" 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 E84 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.

2.03 SOUND-ABSORBING WALL UNITS

- A. Wrapped Fiberglass Panels: Acousti-Panels AP; fiberglass core of 6 to 7 pcf (96 to 112 kg/cu m) with chemically hardened edges, seamless finish material wrapped and bonded to back side of panels.
 - 1. Core Thickness: 2 inch; 2 layers 7 pcf polyester
 - 2. NRC: 2 inch 1.05 for direct mount applications
 - 3. Core Color:
 - 4. Size: Configuration and sizes as noted on drawings.
 - 5. Finish: Manufacturers standard polyester fabric color.
 - a. Fabric to be adhered to face of core and continuously wrapped all edges to backside.
 - 6. Edges: Square
 - 7. Corners: Square
 - 8. Mounting: Two-Part hanger bar and Z-clip.

2.04 FABRICATION

- A. Measure and establish layout of panels and joints of sizes indicated on Drawings within a given area.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

- C. Install units in locations indicated. Unless otherwise indicated, install units with edges in alignment with windows and other units and faces flush.
- D. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
- E. Do not begin installation until substrates have been properly prepared.
- F. Install acoustical units in accordance with manufacturer's instructions.

3.02 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.

3.03 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 09 8433

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**SECTION 09 9123
INTERIOR PAINTING**

PART 2 PRODUCTS

1.01 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

PART 3 EXECUTION

2.01 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.

2.02 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

END OF SECTION 09 9123

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SECTION 10 0249.59
ACOUSTIC BLANKET INSULATION

PART 1 — GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2023.
- B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- D. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- E. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024.
- F. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2025.

1.02 SUMMARY

- A. Section Includes: Glass fiber acoustical blanket insulation for interior partitions and ceilings.

1.03 SUBMITTALS

- A. Product Data: Submit product characteristics, performance criteria, and limitations, including installation instructions.

1.04 QUALITY ASSURANCE

- A. Preconstruction Meeting: Convene a minimum of two weeks prior to commencing work of this section. Agenda shall include materials proposed for use, sequence of construction and coordination with installation of adjacent and covering materials.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to the job site in original packages, containers, or bundles bearing the brand name and manufacturer's identification.
- B. Storage: Store materials in dry locations with adequate ventilation, free from water, and in such a manner to permit easy access for inspection and handling.
- C. Handling: Handle using procedures recommended by the manufacturer for materials and personnel.

1.06 WARRANTY

- A. Warranty: Provide manufacturer's standard limited warranty against manufacturing defects.

PART 2 — PRODUCTS

2.01 MANUFACTURER

- A. Provide Basis of Design product or approved equal.
 - a. Basis-of-Design is product as offered by Owens Corning Insulating Systems, LLC, Toledo, OH 43659; www.owenscorning.com.

2.02 ACOUSTIC BLANKET INSULATION (SOUND ATTENUATION BATTS), FIRE-RATED

- A. Type: Unfaced glass-fiber acoustical insulation, complying with ASTM C665, Type I.
 - 1. Thickness: 3 1/2 inches.
 - 2. Width: 24 inches.
- B. Surface Burning Characteristics: ASTM E84.
 - 1. Maximum flame spread: ???25
 - 2. Maximum smoke developed: ???50

- C. Combustion Characteristics: Passes ASTM E136.
- D. Fire Resistance Ratings: Part of ASTM E119 fire tested wall assemblies.
- E. Meets NFPA 285
- F. Sound Transmission Class: ASTM C423, STC based on manufacturer's published data on thickness and wall assembly.
- G. Dimensional Stability: Linear Shrinkage less than 0.1%

PART 3 — EXECUTION

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this section will be installed. Verify that adjacent materials are dry and ready to receive insulation. Verify mechanical and electrical services within walls have been tested and inspected.
- B. Provide written report listing conditions detrimental to performance of work in this section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with manufacturer's installation instructions. Do not use unfaced insulation in exposed applications where there is potential for skin contact and irritation. Friction-fit blanket insulation in place, until the interior finish is applied. Install batts to fill entire stud cavity, with no gaps, voids, or areas of compression. If stud cavity is less than 8 feet in height, cut lengths to friction fit against floor and ceiling tracks. Walls with penetrations require that insulation be carefully cut to fit around outlets, junction boxes, and other irregularities.
- B. Where walls are not finished on both sides or where insulation does not fill the cavity depth, install supplementary support to hold product in place.
- C. Where insulation must extend higher than 8 feet, provide temporary support to hold product in place, until finish material is applied.
- D. Install installation to cover all top of wall conditions where walls terminate above ceiling without extending to deck.
 - 1. Install a minimum of 24" on each side of wall partitions. Refer to drawings.

3.03 PROTECTION

- A. Protect installed insulation from damage due to weather and physical abuse until protected by permanent construction.

END OF SECTION 10 0249.59

**SECTION 11 61 00
STUDIO LIGHTING SYSTEMS**

PART 1 - GENERAL

1.01 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions.

1.02 RELATED DOCUMENTS

- A. Studio Lighting (SL) Drawings.
- B. Division 01 – General Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- C. Division 05 – Metal Fabrication:
 - 1. The Metal Fabrication Contractor shall provide the work as specified in Division 05 and the Structural Drawings. Including: steel framing and supports for theatrical rigging systems.
 - 2. Steel shown on the Structural drawings will be provided by the Structural Contractor.
- D. Division 26 – Electrical:
 - 1. The Electrical Contractor shall provide the work as specified in Division 26, as indicated on the SL Drawings, and as specified herein.
 - 2. Electrical infrastructure (electrical j-boxes, conduit) for Theatre Systems is shown on SL Drawings and shall be the responsibility of the Division 26 Electrical Contractor.

1.03 DEFINITIONS

- A. The following shall serve as general identifiers as specified herein.
 - 1. Theatre Consultant – D. L. Adams Associates.
 - 2. Architect – Treanor Architects.
 - 3. Contractor – The Theatre Contractor is the firm submitting a proposal to furnish and install the Work as defined within this Specification.
 - 4. Project – The Project is the Theatre Systems installation in the facilities of the Riverton High School Auditorium Addition.
 - 5. Work – The term "Work" means all construction and services specified within this document. The Work includes all related labor, materials, equipment, and services provided, or to be provided, by the Contractor to fulfill the proposal's obligations.
 - 6. Drawings – The term "Drawings" means all Theatre Systems Drawings and associated sketches, details, riser diagrams, etc.
 - 7. Project Location – 200 West 24th Street, Cheyenne, WY, 82001.
- B. As used in the Drawings and Specifications for the Work, certain non-technical words and phrases shall be understood to have specific meanings as follows, regardless of indications to the contrary in the General Conditions or other documents governing the Work.
 - 1. "Furnish" – Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the Theatre Systems Work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims, or encumbrances.
 - 2. "Install" – Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the Work.
 - 3. "New" – Manufactured within the past year and never used.

4. "Provide" – Furnish and Install.
- C. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as described to them in the following list:
 1. "Circuit" – Any specific run of circuitry.
 2. "Circuitry" – Any Work which consists of wires, cables, raceways, and/or specialty wiring method assemblies complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.
 3. "Concealed" (as applied to circuitry) – Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.
 4. "Exposed" (as applied to circuitry) – Not covered in any way by building materials.
 5. "NIC" – Not in Contract
 6. "Normal Work Conditions" – Locations within building confines that are not damp, wet, or hazardous and that are not used for air handling.
 7. "OFE" – Owner Furnished Equipment.
 8. "Patch Panel" – A System of terminal blocks, patch cords, and backboards that facilitate administration of cross-connecting cables.
 9. "Raceway" – Any pipe, duct, extended enclosure, or conduit (as specified for a particular System) which is used to contain wires, and which is of such nature as to require that the wires be installed by a "pulling in" procedure.
 10. "Standard" (as applied to wiring devices) – Not of a separately designated individual type.
 11. "Wiring" – see "Circuitry."
- D. Additional Terms:
 1. The term "shall" is mandatory; the term "will" is informative; the term "should" is advisory.
 2. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway."
 3. The term "custom" indicates systems or components that shall be designed and fabricated by the Contractor based on the drawings and specifications.
 4. The term "future" indicates systems or components that will be added to the system later but shall be provisioned for now.
 5. The term "equal" indicates systems or equipment that is of the same size, color, design, function, efficiency, etc. as of that specified.
 6. Reference to "U.L. (Materials Construction) Standards" shall mean the "Standards for Safety" published by Underwriters Laboratories, Inc

1.04 SCOPE OF WORK

- A. General:
 1. The Work as described herein shall be furnished and installed by one (1) firm alone.
 2. The Contractor is responsible for furnishing the presentation lighting and rigging systems in order that a single contractor has the responsibility of coordinating these sub-systems into an integrated theatrical production facility. This coordination is a major responsibility of the Contractor.
 3. The Contractor shall furnish and install all equipment Theatre Systems described herein.
 4. Presentation and work lighting control wiring shall be provided and installed by the Electrical Contractor and terminated by the Contractor.

5. It is the responsibility of the Contractor to furnish and install all steel not shown on the Structural drawings but required for a complete and operational rigging system. This includes confirming the location, orientation, and dimensions of the building steel to assure that the mounting of the pipe grid rigging system to the building steel can be accomplished per manufacturer's recommendations. Any steel not shown on the Structural Drawings shall be provided by the Contractor as specified herein.
 6. The Contractor shall provide all Work as may be required to make a complete and fully functioning system of that which may not be fully defined in the Contract Documents.
 7. The Contractor shall verify the completeness of the parts list and furnish necessary accessories to execute the intent of the Drawings and Specifications.
 8. The Drawings and Specifications shall be read and used together, system features which are mentioned in one are not necessarily shown in the others. It shall be understood that the Drawings, Specifications, and Equipment Lists are complementary. Where there are conflicts within the documents, request clarification.
 9. The project documentation is, in general, diagrammatic and/or developed to communicate design intent. The Contractor shall coordinate the installation of all devices and/or equipment with the Owner prior to installation based on the existing field conditions.
 10. The Contractor shall coordinate all installed items with associated trades (electrical, mechanical, structural, AV, telecom, etc.) including all necessary cable pass-thrus and structural needs/requirements.
 11. The Contractor shall provide all software programming required to provide fully operational systems.
 12. The Contractor shall provide all equipment and software programming required to provide fully operational systems.
 13. The Contractor shall coordinate the specific programming requirements of the Performance Lighting Control System with a designated Owner representative. All programming written for this project shall be the property of the Owner and shall be provided to the Owner upon completion.
- B. Related Work by Others:
1. Furnishing and installation of load wiring, control wiring, raceway, pull-boxes, and plywood backboards (provided under Electrical Work).
 2. Electrical terminations of relay feeds and relay load wiring.
 3. Structural: Steel shown on the Structural drawings shall be provided by others.
 4. Installation and termination of building network systems.
 5. Cutting, patching, and painting of walls, unless damaged performing the Work described herein.
 6. Equipment and materials provided and installed by others, unless otherwise shown in the Drawings or this Specification, shall include but are not limited to:
 - a. Electrical Outlets.
 - b. Load Wiring.
 - c. Control Wiring.
 - d. Conduit, Raceways and Cable Trays.
 - e. Junction Boxes.
 - f. Telecommunications Outlets.
- C. Coordinated Work:
1. Contractor shall coordinate with Electrical Contractor on raceway/junction box locations for Theatre Systems equipment and routing of load wiring, and all control and power raceway from equipment, terminal and pull boxes to system equipment racks. The Contractor shall coordinate to verify the appropriate raceways are in place.
 2. Coordinate with related trades to schedule the Work and ensure a complete installation in accordance with the schedule outlined by the Owner.

3. Coordinate all IP device requirements with the Telecom Contractor, Owner, and General Contractor.
4. Coordinate all building network connectivity requirements with the Telecom Contractor and Owner.

1.05 GENERAL CONDITIONS

- A. The Contractor represents that they are familiar with and have expertise in the Work of this nature and scope.
- B. The Contractor shall comply with all the regulations, including safety regulations of national, city, local, and other government agencies having jurisdiction concerning the Work of the Contractor. The Contractor shall give all notices and comply with all laws, ordinances, codes, rules, and regulations bearing on the conduct of the Work. If the Contractor performs any work, which is contrary to such laws, ordinances, codes, rules, and regulations, they shall make all changes for compliance and bear all associated costs.
- C. The Contractor shall be responsible to provide and maintain a storage facility. If this storage facility is required to be on-site it shall be the Contractor's responsibility to coordinate the size and spatial requirements with the Owner. The Contractor shall assume full responsibility for the storage facility and all contents, unless otherwise indicated by the Owner.
- D. The Contractor shall provide all protection necessary to safeguard their work from damage by their operations and the operations of others. Unless the Contractor proves to the Owner's satisfaction that the Work has been damaged by others, the Contractor shall promptly repair, adjust, and clean all defective installations and bear all associated costs.
- E. All the Contractor's work shall be tested and inspected by all authorities having jurisdiction and in accordance with all Specifications. The Contractor shall coordinate and cooperate fully and shall provide at no additional cost to the Owner, manpower, drawings, facilities, scaffolds, etc. to reasonably assist the inspectors.
- F. The Owner reserves the right to furnish any materials necessary for the Project.
- G. All permits required for any part of the Contractor's work shall be procured and paid for by the Contractor. The Contractor shall determine all permits required and transmit this information to the Owner. If it is determined that the Contractor's work falls reasonably within another party's permit (General Contractor, Electrician, etc.) the Contractor shall not be required to procure additional permits provided written authorization is provided to the Contractor by the party holding the permit.
- H. The Contractor must state if they intend to utilize a subcontractor and provide said subcontractor's name and address. The subcontractor shall comply with all the same rules, regulations, laws and codes, licenses, etc. as required by the Contractor and as specified herein. The Owner reserves the right to approve or disapprove any subcontractor proposed by the Contractor.
- I. The Contractor, upon receiving notice from the Owner that the Contractor has furnished inferior, improper, or unsound work or materials (including equipment), or work or materials at variance with that which is specified, will, within twenty-four (24) hours, proceed to remove such work or materials and make good all other work or materials damaged thereby, and, at the option of the Owner, the Contractor shall immediately replace such work or materials with work or materials as specified. The removal, replacement, and repair shall be performed at such times and with manpower sufficient, in the judgment of the Owner, to avoid disturbance to occupants, or other ongoing work for the Project.
 1. If the Contractor does not remove such unsound Work within a reasonable time, the Owner may remove it and may store the material at the expense of the Contractor. If the Contractor does not pay the expenses of such removal within ten (10) days' time thereafter, the Owner may, upon written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof, after deducting all the costs and expenses that should have been borne by the Contractor and all expenses of the sale.

2. The Owner shall always have the authority, until final completion and acceptance of the Work, to inspect and reject work and materials which in its judgment are not in conformity with the Drawings and Details, Room Data Sheets and Specifications, and its decision in regard to character and value of Work shall be final and conclusive on both contracting parties. If the Owner permits said Work or materials to remain, the Owner shall be allowed the difference in value or shall at its election have the right to have said Work or materials repaired or replaced, as well as the damage caused thereby, at the expense of the Contractor, at any time within one (1) year after the completion of the entire project, or within such longer period as may be covered by any guaranty; and neither payments made to the Contractor, nor any other acts of the Owner, shall be construed as evidence of acceptance, waiver, or estoppels.
 3. Any expense incurred by the Owner in connection with the foregoing, shall be borne by the Contractor, and the Owner may withhold money due to the Contractor or recover money already paid to the Contractor, to the extent of such expense.
- J. The Drawings for the Work utilize symbols and schematic diagrams that have no dimensional significance. The Work shall be installed to fulfill the diagrammatic intent expressed on the Drawings, field layouts, and shop drawings of all trades.
- K. The Drawings show diagrammatically the battens, suspension locations, controls, etc. So far as possible, the drawings show the arrangement of the equipment which will fit into the spaces available without interference.
- L. The system Drawings generally indicate how the system equipment is to be integrated with other parts of the building. The Contractor shall determine exact locations by job measurements, by checking the requirements of other trades and by reviewing all contract documents.
- M. Whenever job measurements, analysis of the Drawings and Specifications, or progress of other trades indicates that the various systems cannot be installed without significant deviation from the intent of the contract, the Theatre Consultant shall be notified immediately.
- N. Certain details appear on the Drawings for the Work that are specified with regard to the dimensioning and positioning of the Work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated Work.
- O. Information as to general construction and architectural general construction and architectural features and finishes shall be derived from the structural and architectural drawings and specifications and may require ongoing coordination with the Architect and/or Construction Team.
- P. The Work called for under this Contract shall be carried on simultaneously with the work of other trades and Owner functions in such a manner as to not delay the overall progress of the construction project. The Contractor is responsible for all coordination of the Work with other trades.
- Q. Include in the Work all necessary supervision and issuing of all coordination information to any other trades who are supplying work to accommodate the Theatre Systems installation. For items of equipment which are to be installed but not purchased as part of the Work, the Work shall include:
1. Coordination of delivery: Deliver materials in manufacturer's original unopened containers with manufacturer's labels attached. Do not deliver material until spaces to receive them are clean, dry, and ready for their installation. Ship to jobsite only after roughing-in, painting, and other finishing work has been completed, installation areas are ready to accept Work.
 2. Unloading from delivery trucks: Do not deliver or install materials until spaces are enclosed and weather tight, wet work in spaces is complete and dry, HVAC system is operating and maintaining ambient temperature at occupancy levels during the remainder of the construction period.
 3. Safe handling and field storage up to the time of permanent placement in the project.

4. Correction of any damage to the item(s) caused by the Contractor.
5. Mounting in place and connection(s) as specified.

R. Items which are to be installed, but not purchased as part of the Work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the Work will be considered only if presented in writing within one (1) week of the date of delivery to the project of the items in question. The Work includes all procedures necessary to put in satisfactory operation all items for which no claims have been submitted as outlined above.

1.06 SUMMARY

- A. This Section includes the following Theatre Systems in the Broadcast Studio:
1. Pipe Grid.
 2. Presentation Lighting Control System.
 3. Presentation Lighting Instruments and Accessories.

1.07 SYSTEMS DESCRIPTIONS AND FUNCTIONS

- A. Provide all necessary labor, materials, equipment, accessories, transportation, and services required for the installation of a totally integrated technical Theatre System consisting of the following:
1. Presentation lighting system including theatrical lighting relay rack and control system for presentation and work lighting fixtures shall be provided with the following features:
 - a. Up to eight (8) relay circuits provided in a DMX-controlled rack used for presentation lighting.
 - b. Presentation lighting circuits will be distributed to the following locations:
 - 1) Integrated into Pipe Grid Battens (5).
 - 2) Wall Outlet Boxes (4).
 - c. Presentation Lighting Control Network: DMX512/lighting network control interfaces shall be distributed on the pipe grid battens and wall outlet boxes, around the Studio, and at the control position for lighting console and control of LED fixtures, intelligent lights, foggers, etc.
 2. Presentation Lighting Console:
 - a. A professional lighting control console designed for venues using LED lighting shall be provided. In addition to keypad commands, the faders provide hands-on control of intensity and can be used to set manual levels and edit recorded cues and submasters. On demand moving light controls are available to facilitate using conventional accessories like LED fixtures, moving mirror heads, color scrollers, gobo rotators, moving lights, etc.
 3. Presentation Lighting Fixtures:
 - a. Professional quality color-changing LED presentation lighting fixture package, including Fresnel wash light fixtures, fixed lens ellipsoidals, and soft panel lights.
 - b. All fixtures will be equipped with power cables, plugs, lamps, c-clamps, safety cables, color frames, top hats, and barn doors (if appropriate).
 - c. The Contractor shall coordinate the final fixture and accessories package with designated Owner's Representative.
 - d. Contractor shall provide, install, and program initial lighting rep plot, based on final fixture package.

1.08 QUALITY ASSURANCE

- A. Contractor's Qualifications:
1. The Work of this Section will be contracted to a single firm, referred to herein as the Contractor, for undivided responsibility.
 2. The Contractor shall be experienced in the installation of professional theatre systems and have completed within the past five (5) years at least three (3) projects of a size and scope comparable to the project described herein.

3. The Contractor shall have factory-certified programmers for the programming of the control equipment used in this project.
 4. The Contractor shall have capabilities and in-house facilities for installation, shop fabrication and repair service of the Theatre Systems.
 5. The Contractor shall have at least one (1) full-time senior staff member, having five (5) years minimum experience as a theatrical systems installer who will be assigned to this installation. The senior staff member shall be an ETCP Certified Rigger – Theatre. The senior staff member shall:
 - a. Provide all technical liaison between the Contractor and the Theatre Consultant.
 - b. Be responsible for supervision of all technical and engineering work required to execute the contract, and, in particular, approve and sign all shop drawings.
 - c. Represent the Contractor at all meetings and conferences and be present at the job site for final inspection.
 - d. Be at the site during the entire installation period.
- B. Qualification of Contractors:
1. All Contractors desiring to submit bids for the work specified herein must be Qualified in writing by the Theatre Consultant not less than ten (10) days prior to the bid opening.
 2. Bids submitted by Contractors who have not been qualified will not be accepted.
 3. Contractors not listed below, desiring to bid on this installation, shall submit the required qualification statement of Article 1.09, Paragraph B. Qualification shall be subject to Theatre Consultant's approval.
 4. Pre-qualified Contractors, listed in alphabetical order, are as follows:
 - a. Barbizon Light, 2525 North Elston Avenue, D220, Chicago, IL 60647, (800) 935-3920.
 - b. Gopher Stage Lighting, 4141 Cedar Avenue, Minneapolis, MN 55407, (612) 871-0138.
 - c. Heartland Scenic Studio, 5329 Lindbergh Drive, Omaha, NE 68110, (402) 341-9121.
 - d. iWeiss Theatrical Solutions, 815 Fairview Avenue, Unit #10, Fairview, NJ 07022, (888) 325-7192.
 - e. LVH Entertainment Systems, 1600 Maxwell Drive, Suite #5, Hudson, WI 54016, (715) 377-7534.
 - f. MainStage Theatrical Supply, Inc., 907 South 1st Street, Milwaukee, WI 53204, (414) 278-0878.
 - g. Oasis Stage Werks, 249 South Rio Grande Street, Salt Lake City, UT 84101, (801) 363-0364.
- C. Minimum Performance Requirements: To meet the minimum performance requirements, the Contractor shall be responsible for the following:
1. Each component's conformance with the exemplary equipment's published specifications and other requirements as stated herein.
 2. Electrical Components: Listed and labeled per NFPA 70, Article 100 by a testing agency acceptable to authorities having jurisdiction.
 3. Safety: The pipe grid systems shall conform to all applicable code requirements and shall be in conformance with ESTA and USITT industry standards of operation and practices for rigging systems. All materials and arrangements shall comply with applicable performance requirements.
 4. Detailed checking of each item of equipment provided, each portion of the installation, and of the complete installation to find and remedy any defects therein.
 5. The initial adjustment of all electronic control systems, and, under the direction of the Theatre Consultant, making the final adjustment of these items.

6. If so directed by the Theatre Consultant, the Contractor shall make final adjustments to control systems and alignment of equipment. To establish a definitive standard of performance, the systems and/or related components specified herein shall be as manufactured, supplied, and installed by the contractors listed and the exemplary equipment manufacturers listed in this specification.
- D. Applicable Standards and Codes:
 1. American Hardboard Association (AHA): AHA A135.4-95: Basic Hardboard.
 2. American Plywood Association (APA): Performance Standards and Policies for Structural Use Panels.
 3. American Society of Civil Engineers (ASCE): ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
 4. Architectural Woodwork Institute (AWI): Quality Manual, 8th Edition.
 5. American Standards for Testing and Materials (ASTM):
 - a. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.
 - b. ASTM 48 – Specification for gray iron casting.
 - c. ASTM 120 – Specification for black and hot dipped zinc coated, (galvanized) steel pipe for ordinary use.
 - d. ASTM A 500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - e. ASTM A513 – Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
 - f. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low Alloy with Improved Formability, and Ultra High Strength.
 - g. ASTM B85 – Standard Specification for Aluminum Alloy Die Castings.
 - h. ASTM B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - i. ASTM B221 – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - j. ASTM B429 – Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - k. ASTM C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - l. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 - m. ASTM E 413 – Classification for Rating Sound Transmission.
 6. International Building Code (IBC).
 7. National Association of Architectural Metal Manufacturers (NAAMM): Metal Finishes Manual for Architectural and Metal Products.
 8. National Electric Manufacturers' Association (NEMA): NEMA LD 3-2000 – High Pressure Decorative Laminates.
 9. U.S. Department of Commerce, National Institute of Standards and Technology: DOC PS 1: U.S. Product Standard for Construction and Industrial Plywood.
 10. American Society of Mechanical Engineers (ASME).
 11. United States Institute for Theatre Technology (USITT).
 12. National Electric Code (NEC).
 13. NFPA International (NFPA): NFPA 701: Fire Tests for Flame-Resistant Textiles and Films.
 14. NFPA-79 (Electrical Standards for Industrial Machinery).
 15. American Nation Standards Institute (ANSI):
 - a. ANSI B17.1M – Keys and key seats.
 - b. ANSI B18.2.1&2 – Specification for square and hex bolts and nuts.
 - c. ANSI B106.1M – Design of Transmission Shafting.
 16. Any and all applicable local governmental codes.

- E. Pipe Grid Systems, Minimum Standards of Safety, the following factors shall be used:
 - 1. Cables and Fittings: 8:1 Safety Factor.
 - 2. Cable D/d ratio: Sheave tread diameter is the minimum D/d ratio per the "Wire Rope User Manual" or recommended by the wire rope manufacturer.
 - 3. Tread Pressures: 500 pounds for cast iron, 900 pounds for Nylatron, 1,000 pounds for steel.
 - 4. Steel: 1/5 of yield strength or per AISC Specification.
 - 5. Bearings: Two (2) times required load at full speed for 2,000 hours.
 - 6. Bolts: Minimum SAE J429 Grade 5 (ISO R898 Class 8.8), zinc plated.
- F. Code Compliance: All products and work shall be superior to or equal to that which is required by governing codes, ordinances, rules, and regulations.
- G. All bid proposals shall be based on materials, equipment and installation as specified herein. All deviations and exceptions to the specifications must be approved by addendum.
- H. Field Welding: Conform to ASME standards. Welders employed to be certified and recertified within the previous six (6) months for position, rods, and types of steel used in all rigging systems.

1.09 SUBMITTALS

- A. Submittals shall be in accordance with Division 01 requirements.
- B. Contractor Qualification Statement: Non-prequalified contractors wishing to bid on the Work specified herein shall submit for approval, brochures bound in flexible binders containing a statement of the Contractor's qualifications. As a minimum, this submittal shall include the following:
 - 1. A list of broadcast studios of comparable size and scope to that described herein, completed by the Contractor in the last five (5) years. Show project name and address, year of completion, and the name and telephone number of a person to contact who is a representative of the Owner or User.
 - 2. A personal résumé of formal education and experience of the qualified staff engineer who would direct the Work.
 - 3. A description of the Contractor's capabilities and facilities for assembly, shop fabrication, repair, and servicing of theatre equipment.
 - 4. Certification(s) from the lighting control system manufacturer(s) certifying that the Contractor's software programmers have been factory trained and are qualified to perform the installation.
 - 5. The Contractor shall provide proof that the project supervisor holds ETCP Certified Rigger – Theatre Certification.
- C. Shop Drawing Submittals: Show fabrication and installation details for the rigging assemblies, pipe grids, presentation lighting system, etc. At a minimum, shop drawing submittals shall include the following and shall be submitted as a single package:
 - 1. A complete bill of material showing a list of equipment to be provided, with quantities, including those items which are to be fabricated by the Contractor.
 - 2. A complete set of manufacturers' equipment specifications with detailed technical information describing and illustrating all components and materials to be used in the installation of the systems. This set shall include items listed by manufacturer and model number and any other components needed to provide a complete functional system.
 - 3. Provide manufacturer's specification sheets for each type of product indicated.
 - 4. Plans, elevations, details, and assembly drawings.
 - 5. Assembly drawings shall include all major components deemed necessary for review by the Theatre Consultant. All assemblies shall include weights, dimensions, and, where applicable, loads.
 - 6. Include information required for coordination of work by other trades.
 - 7. Operating clearances.

8. Complete rigging schematics including dimensions, weights, capacities, and loads imposed by all components shall be provided.
 9. Requirements for supporting all theatrical rigging equipment. Verify capacity of each rigging component to support loads.
 10. Prior to submittal, the theatrical rigging system shop drawings must be approved and stamped by a licensed structural engineer, registered in the state in which the Work is being conducted.
 11. Locations of equipment components, switches, and controls. Differentiate between manufacturer-installed and field-installed wiring.
 12. One-line diagrams/schematic diagrams shall be submitted for the theatrical lighting system. Wiring diagrams shall show power, signal, and control wiring.
 13. Lighting Control Systems user interface navigation. This shall include page by page graphics and descriptions of functions for each page and each programmable button.
 14. The data furnished by the Contractor shall be sufficient to enable the Theatre Consultant to determine whether the equipment, materials, and installation the Contractor proposes to furnish comply with the requirements of this specification.
 15. The Contractor shall provide other information or materials requested by the Theatre Consultant when there is question of compliance with the intent of the Drawings and Specifications.
- D. Product Certificates and Data: Manufacturer's data sheets on each product to be used, including:
1. Provide test results by certified independent testing laboratory indicating compliance with performance requirements.
 2. Rated capacities, construction details, material descriptions, dimensions of individual components, profiles, and finishes.
 3. Delivery, storage, handling, and installation instructions and recommendations.
 4. Maintenance instructions and recommendations.
- E. Coordination Drawings: Project-specific Coordination Drawings, indicating the following items drawn and coordinated with each other. Include information required by Installers of each item to coordinate the Work. Include the following:
1. Relationship of items shown on separate Shop Drawings.
 2. Dimensions and required clearances of adjacent or related work.
 3. Order of assembly of separate items.
 4. Information required for interface with other trades and components, including mechanical, electrical, and communication work.
- F. Warranty: Sample of special warranty.
- G. Closeout Submittals:
1. Operation and Maintenance Data: For adjusting, repairing, and replacing components and accessories.
 2. Troubleshooting Guide.
 3. Warranty: Submit manufacturer's warranty.
 4. After the final Consultant site visit and final punch list has been completed, submit the following:
 - a. Operation Manual: Provide the following in a neatly bound binder with tabbed dividers between sections. Also, provide a digital copy in PDF format on a USB solid state memory drive.
 - 1) Title Page
 - 2) Table of Contents
 - 3) Description of each system including key features and operational concepts.
 - 4) User Operating Instructions for each of the systems.
 - 5) Setup diagrams and instructions to use in typical situations as directed by the Owner.

- 6) Single-line block diagrams showing all major system components.
 - 7) Manufacturer's operation manuals and information sheets for equipment intended for operation by system users.
 - 8) Test certificates from manufacturers.
 - 9) Recommended Spare Parts List.
 - b. Maintenance Manual: Provide the following in a neatly bound binder with tabbed dividers between sections. Also, provide a digital copy in PDF format on a CD-ROM or USB solid state memory drive.
 - 1) Title Sheet
 - 2) Table of Contents
 - 3) Company name, address, telephone number, e-mail address, website, and contact name for system service or maintenance
 - 4) Listing of all equipment and materials with names of manufacturers and model numbers or part numbers.
 - 5) Regular maintenance requirements.
 - 6) Product manufacturer's warranties and a typed one-year system warranty explicitly covering all materials and labor.
 - 7) Manufacturer's service manuals for all major equipment items.
 - 8) A recommended preventative maintenance schedule with reference to the applicable pages in the manufacturer's maintenance manuals. Where the manufacturer provides inadequate information, provide the information necessary for proper maintenance.
 - 9) Scaled PDF drawings of all system assembly drawings necessary to perform maintenance on the systems.
 - 10) Provide a working copy of the latest version of all software required to operate or configure the systems specified herein.
 - 11) All software shall be fully documented, and that documentation included.
 - 12) Software shall be furnished on a CD-ROM or USB solid state memory drive attached to the binder.
 - 13) All user definable software configurations and/or programming shall become the sole property of the Owner. This includes all source code, source code copyrights, and related documentation.
 - c. As-Built Drawings:
 - 1) Electronic full-size drawings shall be submitted to the Owner after final acceptance. These are to be fully revised by the start-up and installation personnel to reflect the actual finished installation. The as-built drawing set is to be 100% complete including all schematics, details, and bills of material necessary to maintain and repair all the systems.
 - 2) Each drawing shall be stamped and dated "As-Built Drawing."
 - 3) Any revisions or modifications during the warranty period will require that the "As-Built Drawings" be updated.
 - 4) Maintain a full set of shop drawings at the project site marked up to indicate actual locations of equipment, boxes, and other items called for in this section. After the final Consultant site visit, compile the mark-ups into an electronic set of as-built drawings in AutoCAD or Revit and provide to the General Contractor, Architect, and Consultant.
 - d. Training Materials: Provide two (2) DVDs and one (1) thumb drive of the recorded instruction and training sessions to document in accordance with Article 3.06.
- H. Field Quality Control Reports: Documenting inspections and demonstrations of installed products and equipment.

1.10 PROJECT CONDITIONS

- A. Field Conditions: The Contractor shall examine all attachment areas and conditions under which the theater equipment is to be installed. Notify General Contractor in writing of any conditions detrimental to the proper and timely completion of the work.
- B. Field Measurements: Verify actual dimensions of openings and construction contiguous with, rigging and openings by field measurements before fabrication and indicate measurements on Shop Drawings.
- C. The drawings show diagrammatically the stage and pipe grid, control devices, etc. So far as possible, the drawings show the arrangement of the equipment which will fit into the spaces available without interference.
 - 1. Coordinate installation and location of blocking and supports as requested.
 - 2. Verify openings, clearances, storage requirements, and other dimensions relevant to the installation and final application.
 - 3. Where applicable, coordinate locations of electrical junction boxes.
- D. The system drawings are approximately to scale and generally indicate how they are to be integrated with other parts of the building. The Contractor shall determine exact locations by job measurements, by checking the requirements of other trades and by reviewing all contract documents.
- E. The Contractor is responsible for monitoring the progress of other trades to prevent out of sequence installation of equipment.
- F. Whenever job measurements, analysis of the drawings and specifications, or progress of other trades indicates that the various systems cannot be installed without significant deviation from the intent of the contract, the Architect and Theatre Consultant shall be notified immediately. Work in the general area shall cease until a resolution to the question has been approved.

1.11 WARRANTY

- A. The Contractor shall warranty all material furnished and/or installed by them and their workmanship to be of first-class quality, and to replace or repair any defects within a period of one (1) year after date of final acceptance.
- B. Paint, exterior finishes, fuses, and lamps are excluded from the above warranty, except when damage or failure results from defective materials, workmanship covered by the warranty.
- C. Any manufacturer's warranties that exceed a period of one (1) year shall be transferred to the Owner for the remaining life of the warranty.

1.12 MAINTENANCE SERVICE CONTRACT WARRANTY

- A. Provide a written Maintenance Service Contract that contains the following:
 - 1. Replacement and/or repair of defective materials or faulty workmanship within seventy-two (72) hours of discovery at no cost to the Owner during the period of the warranty.
 - 2. Maintenance Service Contract shall be for a period of one (1) year from the final acceptance date.
 - 3. Service shall consist of at least one (1) visit six (6) months and one (1) visit eleven (11) months after final acceptance for checking the equipment and making any necessary adjustments.
 - 4. If, during this period, any system component is out of service for more than one (1) week due to unavailability of parts or service, Contractor shall supply and install an identical component. If an identical component is not available, an equivalent component shall be substituted, but only with the approval of the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. All components shall be fabricated to resist rust and corrosion. Consideration of the job site environment during installation and storage will dictate measures to ensure that all equipment is free of rust at the time of final acceptance. Rust appearing during the Warranty period shall be corrected by the Contractor at no expense to the Owner.
2. All metal parts shall be free from rust, dirt, and welding spatter. All new weldments or other metal components shall receive a coat of rust inhibitor primer prior to component assembly. All assemblies shall receive a finish coat of paint. Unless specifically noted otherwise, all rigging components and equipment shall be painted a flat medium gray color.
3. All materials shall be new and of first quality.
4. All equipment shall be of bolt-up construction whenever possible. Equipment which must be welded in place shall have a welded sub-base which is bolted to the base so that the assembly may be removed for servicing by loosening bolts between the base and sub-base.

B. Manufacturer:

1. For all equipment, materials, and products not identified by part number and manufacturer, performance specifications which are published in the most recent manufacturers' data sheets available at the time of bidding this contract shall be applicable to the present work as though fully written herein.
2. For equipment, materials, and products not identified by part number and manufacturer, the Contractor may select items which conform to the functional and/or technical specifications. For all such items, the Contractor shall submit for approval all technical data which is available from the supplier or manufacturer. Acceptability for use in the systems shall be determined by the Theatre Consultant. Such items shall be installed only after receipt of written approval.

C. Hardware:

1. All hardware (bolts, nuts, washers, etc.) shall be zinc or similarly plated, manufactured in the United States of America, and SAE J429 Grade 5 or better.
2. J-bolts shall not be used for any application to the pipe grid rigging system.
3. All bolts shall be of sufficient length to extend a minimum of two (2) full threads beyond their nut.
4. Self-locking nuts shall be used except where specific engineering reasons dictate the use of other styles. All nuts which are not self-locking shall have an appropriate lock washer.
5. Wherever set screws are used in mounting a drum or coupling to a shaft, "Lock-Tite" or similar thread locking adhesive shall be applied to the set screw before final assembly. This thread locking adhesive shall not be the permanent type but allow for the removal of the set screw for maintenance or inspection purposes. Shafts and/or keyway keys shall be counter-bored slightly where the set screw meets the shaft or key to prevent lateral movement should the set screw loosen slightly.
6. Hoisting hardware shall be galvanized, or zinc plated.
7. Threaded Rod shall be 3/8" threaded rod, Unistrut HTHR037.
8. All cable clips shall be drop forged and shall be tightened before loading and then torqued to manufacturer's specifications when cable is under load. Malleable cable clips shall not be used.
9. Acceptability for use in the systems shall be determined by the Theatre Consultant. Such items shall be installed only after receipt of written approval.

D. Substitutions:

1. Substitutions of equal equipment, beyond product listed, will be permitted only if such equipment is listed in an addendum to this specification.
2. Address requests for inclusion of substitutions to the Theatre Consultant. Accompany any request for substitution with manufacture-measured data proving the equivalence of the proposed substitute in quality and performance. The Theatre Consultant shall be the final judge of the acceptability of submitted substitution.
3. Failure to submit a request for substitution shall automatically disqualify the manufacturers from consideration of approval.

2.02 PIPE GRIDS

A. General:

1. A pipe grid consisting of 1-1/2", schedule 40 Grade A black steel pipe shall be suspended from the ceiling structure of the Broadcast Studio to allow for the mounting of the presentation lighting fixtures.
2. The pipe grid layout shall be similar to that shown on SL Drawings. All materials shall be provided, including miscellaneous hangers and hardware necessary to install a complete system.
3. Pipe Battens:
 - a. The horizontal batten material shall be 1-1/2", schedule 40 Grade A black steel pipe.
 - b. The entire pipe shall be primed and painted with two (2) coats of flat black paint.
 - c. The vertiacal battens shall be MegaBattens and are covered in section 2.03.
4. Overlap Brackets: Overlap or intersection brackets are to be of cold rolled steel, plated black, stamped to fit pipe battens for secure and easy connection of two (2) overlapping pipes. Rota-locks are not acceptable. Provide one (1) overlap bracket at each point where two (2) pipes cross at a 90-dregree angle.
5. Pipe Grid Suspension:
 - a. Distance between pipe grid hangers shall not exceed 8'-0" along pipe.
 - b. Acceptable Suspension Methods:
 - 1) Threaded Rod Hangers: Provide hangers as indicated on SL Drawings. Quantities as required.
6. Finish: The finished pipe grids shall be level within 1/2" over the entire area. The pipe grids shall resist horizontal sway as demonstrated by one (1) person pushing horizontally while on a ladder. The pipe grids shall be free of bow and deflection. The pipes shall be installed in neat, even rows and columns

B. The exemplary pipe grid and hanging hardware includes:

DESCRIPTION	MANUFACTURER	MODEL	QTY
Locking Nut			A/R
Fender Washer			A/R
3/8" Threaded Rod	Unistrut	HTHR037 or equal	A/R
Full Pipe Clamp – Perpendicular	The Light Source	MBATB	A/R
Overlap Clamp – 90-Degree	The Light Source	MGB	A/R
Threaded Rod Hanger	The Light Source	MBAT-TRH.375B	A/R
Bar Joist Washer	The Light Source	BJW3/8B	A/R
1-1/2", Schedule 40, Steel Pipe, Black	JR Clancy	015-67R	A/R
Pipe Splice	The Light Source	MQSB	A/R

2.03 THEATRICAL DIMMING SYSTEMS

- A. General:
- Principal items of equipment are identified herein by manufacturer and part number. Alternate manufacturers and part numbers are given in instances where equivalence has been determined.
 - Alternate manufacturers shall provide a system equivalent to that described herein, and which meet the same performance capabilities as the equipment listed in this Section.
 - For items identified by manufacturer and part number, performance specifications which are published in the most recent manufacturer's data sheets available at the time of bidding shall be applicable to the present Work as though fully written out herein.
 - For items not identified by manufacturer and part number, the Contractor may select items which conform to the functional and/or technical specifications. For all such items, the Contractor shall submit for approval all technical data which is available from the manufacturer.
 - Acceptability for use in the presentation relay system shall be determined by the Theatre Consultant. Such items shall be installed only after receipt of written approval by the Theatre Consultant.
- B. Dimming and Distribution Equipment: The manufacturers and their products listed below exemplify systems with equipment and components meeting the basic requirements and intent of this specification:

DESCRIPTION	MANUFACTURER	MODEL	QTY
Relay Distribution Rack, 8-Zone Controller Cabinet – RP RK-1	ETC	UFMP8	1
Lighting Control Distribution Equipment Cabinet – LC RK-1	ETC	DIN28	1
w/ Gateway	ETC	RSN-DMX1-DIN	1
w/ 8-port DMX Optosplitter	ETC	RSN-OPTO-8DIN	1
w/ Power Supply	ETC	E-SPS-DIN	1
w/ Network Switch	Pathway Connectivity	PWVIA-DIN-P8-RJ45	1
w/ Power Supply	Pathway Connectivity	PWPWR DIN TERM 100W 48VDC	1
Wall Box (1 Circuit; 1 Edison Connectors /DMXout) – W	ETC	9201A/DMXout	4
Plug-In Station (RJ45x2) – C	ETC	ECPB-Netx2	1
House Light Master Station – TS	ETC	ETS-4	1
Pipe Grid Batten 20'-0", (1) 20A circuit per batten with 5-pin DMX outs, matte black. Power input: 3' Whip	The Light Source	PDP1.5B240-1WE311X15-EX16F	4
w/ Distribution Plate – LD	ETC	Custom, per drawing	4
w/ DMX I/O Cable, 5'	ETC	CD5-DMX	4
Pipe Grid Batten 16'-0", (1) 20A circuit per batten with 5-pin DMX outs, matte black. Power input: 3'	The Light Source	PDP1.5B192-1WE311X12-EX16F	1

DESCRIPTION	MANUFACTURER	MODEL	QTY
Whip			
w/ Distribution Plate – LD	ETC	Custom, per drawing	1
w/ DMX I/O Cable, 5'	ETC	CD5-DMX	1
Lighting Control Console	ETC	CS40AV	1
w/ Dust Cover	ETC	CS40DC	1
w/ Case	Pelican	CS40 PC	1
w/ Net Control Cable, 25'	ETC	CD-25Net	1

- C. Alternate Equipment Manufacturers: The following manufacturers of distribution equipment are approved alternates:
1. SSRC.
 2. Rigging Innovators.
 3. Approved equal.

2.04 PRESENTATION LIGHTING INSTRUMENTS

- A. Provide, install, and program presentation lighting instruments. Instruments shall be complete with c-clamp, male twist lock to Powercon or True1 connectors for presentation light fixtures, color frames (if appropriate), 5'-0" DMX control cables, and safety cables.
- B. Fixtures and associated accessories will be coordinated with the Owner's Representative and reviewed by the Theatre Consultant.
- C. Contractor shall submit cost data and other descriptive data to establish the basis used by the Contractor for determining attributable costs in Contract Allowance.
- D. Any Allowance amount not fully consumed shall be adjusted by a credit change order.
- E. Equipment List:

DESCRIPTION	MANUFACTURER	MODEL	QTY
LED Ellipsoidal – Light Engine with Shutter Barrel	ETC	CSSPOTJR2550	6
w/ Pipe Clamp	ETC	400CC	6
w/ Safety Cable	ETC	400SC	6
w/ Power Input Cable	ETC	T1PA-A	6
w/ Color Frame	ETC	400CF	6
LED Fresnel	ETC	CSFRESVMV	8
w/ Pipe Clamp	ETC	400CC	8
w/ Safety Cable	ETC	400SC	8
w/ Power Input Cable	ETC	T1PA-A	8
LED Soft Panel Light	DeSisti	S1VW.MO	8
w/ Pipe Clamp	ETC	400CC	8
w/ Safety Cable	ETC	400SC	8
w/ Power Input Cable	ETC	DPA-A	8
w/ Yoke	DeSisti	S1MO.110.40 M.O.	8
w/ Spiggot	DeSisti	95.100	8
w/ Honeycomb Diffuser	DeSisti	S1-HCN	8
5' Twistlock Jumper Cable	Lex	BE7000-5	20
10' Twistlock Jumper Cable	Lex	BE7000-10	10

DESCRIPTION	MANUFACTURER	MODEL	QTY
25' Twistlock Jumper Cable	Lex	BE7000-25	1
5' DMX Control Cable	ETC	CD5-DMX	10
10' DMX Control Cable	ETC	CD10-DMX	10
5' powerCON Jumper Cable	ETC	DPJ-5	5
10' powerCON Jumper Cable	ETC	DPJ-10	5
5' TRUE1 Thru Jumper Cable	ETC	T1PJ-5	20
10' TRUE1 Thru Jumper Cable	ETC	T1PJ-10	5
5' powerCON plug to TRUE1 receptacle adapter cable	ETC	DPT1A-5	5
5' TRUE1 plug to powerCON receptacle	ETC	T1DPA-5	5
Telescoping, Rolling Boom Base	Altman	526/3-5	2
Side Arms	The Light Source	MSAB12	2

PART 3 - EXECUTION

3.01 COORDINATION

- A. The Contractor shall coordinate this Work with the other electrical work and the work of other trades.

3.02 SITE INSPECTION

- A. All site conditions shall be verified before beginning Work. All work required to properly install and secure items in place shall be provided. Any cutting or drilling of structural work shall be done only with prior approval.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 WORKMANSHIP

- A. The Contractor shall provide a trained foreman who shall supervise the installation of all theatre equipment. All work shall be done by mechanics skilled in their trade and in accordance with accepted shop drawings.

3.04 INSTALLATION

- A. Installation of all equipment shall be true to plumb, line, or level. All material, hardware, supports, and other items required for a complete and correct installation shall be supplied.
- B. The Contractor shall do all cutting and patching necessary for proper installation of the system and shall repair any damage done by himself or his workmen. Any required penetration of slabs of CMU walls shall be made by a cutting method rather than by a concussive method.
- C. Any required penetration of slabs or CMU walls shall be made by a cutting method rather than by a concussive method.
- D. Install Work neatly, with boxes, equipment, etc. plumb and square. Keep the job adequately always staffed. Designate a field supervisor to be present on the job site and in responsible charge during all phases of installation and check out. Maintain same supervisor throughout the execution of the work unless circumstances beyond the control of the Contractor intervene. Install the system in cooperation with other trades to achieve coordinated progress and satisfactory results. Watch for conflicts with work of other trades on the job. Execute without claim for extra payment, moderate moves, or changes as are necessary to accommodate other equipment or preserve symmetry and pleasing appearance.

- E. Locate all apparatus requiring adjustments, cleaning, or similar attention so that it will be accessible.
- F. All supporting structures and enclosures supplied by the Contractor, not having a standard factory paint finish, shall be painted. Paint specifications and color shall be supplied by the Architect.
- G. Clearly, logically, and permanently mark switches, connectors, jacks, relays, receptacles, cables, and cable terminations.
- H. Etch, engrave, silk screen, or apply in a similar permanent manner all legends and markings on all custom panels and receptacle plates. Embossed tape, presstype, etc., are not acceptable.
- I. The equipment specified herein must be capable of operation in environments of normal humidity, dust, and temperature. The Contractor should avoid installing equipment where extreme environmental conditions can occur and shall be responsible for protection of equipment and related wiring from such conditions.
- J. The Contractor shall take precautions to prevent electromagnetic and electrostatic hum. Install the equipment to provide safe operation. Provide ventilation as required to maintain equipment within the manufacturer's specified temperature limits.
- K. Provide all cables necessary for interconnection of permanently mounted equipment. Use terminations required to achieve full function of equipment as specified herein.

3.05 SYSTEM START UP, OWNER'S INSTRUCTION, AND COMMISSIONING

- A. A theatrical lighting system factory representative shall provide initial inspection, troubleshooting, and checkout of the theatrical lighting system prior to its being energized.
- B. When all Work is complete and equipment is adjusted for suitable operation, the Contractor shall schedule an inspection by the Theatre Consultant. All workmen required to operate the equipment and to perform any adjustments and tests that may be required shall be provided. During the scheduled test period, no other work will be done in the Stage, Auditorium, and/or Classroom areas. Any equipment failing to meet approval shall be repaired or replaced and the inspection rescheduled with complete testing repeated until approval and final acceptance.

3.06 INSTRUCTION AND TRAINING

- A. A minimum of three (3) hours of instruction in equipment operations, safety procedures, and maintenance shall be furnished for the dead-hung theatre rigging system.
- B. A minimum of six (6) hours of instruction in equipment operation and maintenance shall be furnished for the presentation lighting relay system. Training shall be divided into two (2), three-hour sessions.
- C. A minimum of four (4) hours of instruction in equipment operation and maintenance shall be furnished for the motorized rigging systems. This item shall be included if Add Alternate 3A and/or 3B are selected.
- D. Training and instruction shall be provided in the presence of the Theatre Consultant; however, this condition may be waived at the Theatre Consultant's discretion.
- E. Training will be recorded by the Contractor. Contractor shall provide two (2) copies of the training video on a DVD and a duplicated copy on a USB drive to the Owner. Contractor will supply the equipment necessary to record the training session(s).
- F. During the training, the participants shall be given opportunities for "hands-on" experience with operating the controls. There shall be demonstrations using the systems themselves as aids. Personnel for instruction and training for the Theatre Systems shall be designated by the Owner.

END OF SECTION 11 61 00

**SECTION 12 2200
CURTAINS AND DRAPES**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films; 2023, with Errata.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Drapes.
 - 2. Drapery tracks, Rods, Grommets and Rings.

1.04 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Drapery Tracks and Rods: Include maximum weights of drapes that can be supported.
 - 2. All Hardware required for installation.
 - 3. Fabrics, Linings, trim.
 - 4. Textile treatments.
- B. Shop Drawings:
 - 1. Drapery Tracks: Show installation and anchorage details and locations of controls.
 - 2. Drapes: Show sizes, locations, and details of installation.
- C. Samples for Initial Selection: Manufacturers full color line of fabric indicated.
- D. Samples for Verification as follows:
 - 1. Drapery Tracks: 18 inches long, with carriers, controls, and accessories.
 - 2. Drapery Fabrics: For each color and pattern indicated, 18" square minimum, from dye lot to be used for the Work and with specified textile treatments applied. Show complete pattern repeat if any. Mark top and face of fabric.
 - 3. Textile Trims: For each color and pattern indicated, 18 inches long.
 - 4. Drape Fabrication: For each heading, fabric, color, and pattern indicated, minimum 18" panel to verify details of fabrication and thread colors.
- E. Product Schedule: For drapes and drapery hanging rods. Use same designations indicated on Drawings.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For drapery track installation; reflected ceiling plans drawn to scale and coordinating track installation with openings and ceiling-mounted items, on which the following items are shown:
 - 1. Ceiling components.
 - 2. Structural members to which hanging rods are attached.
- B. Product Certificates: For each drapery fabric treated with flame retardant, signed by fabric supplier and indicating treatment durability and cleaning procedures required to maintain treatment effectiveness.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For products installed to include in maintenance manuals.

1.07 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. Drapery rod for concealed installation: For each size indicated, equal to 5 percent of amount installed, but no fewer than 1 full size unit.
2. Drapery Hanging Rings: For each type indicated, equal to 5 percent of amount installed, but no fewer than 10 of each type.
3. Drapery Fabrics: For each fabric, color, and pattern indicated, from the same product run, full-width lengths equal to 5 percent of amount installed, but no fewer than 10 yards of each fabric, color, and pattern.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications: For drapes and drapery tracks, fabricator of drapes.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 1. Build mockup at location and in size shown on Drawings.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements before drape fabrication, and indicate measurements on Shop Drawings.
- B. Scheduling: Do not deliver or install drapes until after other finish work, including painting, is complete and spaces are otherwise ready for occupancy.
- C. Temporarily hem drapes at initial installation, with final hemming at the end of 6 months to accommodate stretch over 1 complete heating and cooling cycle.

PART 2 PRODUCTS

2.01 DRAPERY SYSTEM

- A. Provide Basis of Design System as listed below or preapproved equal system and components.
- B. Source Limitation Hardware: Provide entire system, including individual components, from a single manufacturer.
 1. Basis of Design is Rod, Supports and accessories as offered by Artisan Drapery Rod Company of Dallas TX (214) 653-1733.
- C. Source Limitation Drape: Obtain each color and pattern of drapery fabric from a single dye lot.
 1. Basis of Design is Drapery System as offered by NorthEast Stage of 2299 Atlantic Ave, Manasquan, NJ 08736. (732) 431-2201.

2.02 DRAPERY RODS AND ACCESSORIES

- A. Drapery Rods and Hanging associated accessories :
 1. Basis of Design components as listed below:
 - a. Drapery Rod Is the 3 inch Smooth Wood Rod with Oxfordshire Finial.
 - b. Rings to be 4 inch Wood style ring . Provide Ring Glide Tape
 - c. Mounting Brackets to be Churchill Zip Bracket style with Ceiling Mount feature, designed to support weight of track assembly and drape plus force applied to operate track.
 - d. ½" Hollow Zip Wand, 72 inches, Color as selected.
 - e. End stops and accessories as required for full installation to support designated drape weights and movement.
 - f. Lengths and configurations as indicated on drawings.
 - g. Support Capability: Weight and movement of drape indicated, mounted on track length indicated.
 - h. Finish: As selected by Architect from manufacturers full range of standard and premium finishes.

2.03 DRAPES

- A. Source Limitations: Obtain each color and pattern of drapery fabric and trim from one dye lot.

- B. Fire-Test-Response Characteristics: For fabrics treated with fire retardants, provide products that pass NFPA 701 as determined by testing of fabrics that were treated using treatment-application method intended for use for this Project by a testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Drape (Double Sided panels)
 - 1. Provide Double sided Back to Back Drape design, finished both sides.
 - 2. Heading:
 - a. Box Pleats: 200 percent fullness (acoustical); three-fold (fingers) each pleat.
 - b. Pleat Spacing: As determined by panel widths, with even spacing.
 - c. Heading Accessories:
 - 1) Nonwoven buckram.
 - 3. Drapery Fabric:
 - a. Basis of Design Fabric is Imperial Velour IFR Acoustical Velour as offered by Northeast Stage.
 - b. Fabric Width: 54"
 - c. Fabric Weight: 32 oz per linear yard
 - d. Flame Retardancy: Inherently Flame Retardant (IFR)
 - e. Fiber Content: 100% Polyester
 - f. Color as selected by Architect from Manufacturers full line.
 - g. Flame Test Certification:
 - 1) NFPA 701 Small Scale
 - 2) NFPA 701 Test Method #01
 - 3) California Title 19
 - h. Acoustical Noise Reduction / Sound Absorption:
 - 1) Noise Reduction Coefficient: 1.00
 - 2) Sound Absorption Average: 1.00
 - 4. Lining Fabric:
 - a. Product: Basis of Design is Showstopper Lining Fabric IFR Acoustical weight as offered by Northeast Stage.
 - b. Fabric Width: 72 inch
 - c. Fabric Weight: 15 oz per linear yard.
 - d. Flame Retardant: Inherently flame retardant (IFR)
 - e. Fabric Content: 100% Polyester
 - f. Flame test Certifications:
 - 1) NFPA 701 Test Method #01
 - g. Color: As selected by Architect from manufacturer's full line of regular and premium colors.
 - 5. Tiebacks: Match Drapery.
 - 6. Hem Weights: 1-inch- (25-mm-) square lead weights.
- D. Drape (Single side panels)
 - 1. Provide Single sided Drape design, matching Double sided drapes in all visual aspects.
 - 2. Heading:
 - a. Box Pleats: 200 percent fullness (acoustical); three-fold (fingers) each pleat.
 - b. Pleat Spacing: As determined by panel widths, with even spacing.
 - c. Heading Accessories:
 - 1) Nonwoven buckram.
 - 3. Drapery Fabric:
 - a. Basis of Design Fabric is Imperial Velour IFR Acoustical Velour as offered by Northeast Stage.
 - b. Fabric Width: 54"
 - c. Fabric Weight: 32 oz per linear yard
 - d. Flame Retardancy: Inherently Flame Retardant (IFR)

- e. Fiber Content: 100% Polyester
- f. Color as selected by Architect from Manufacturers full line of standard and premium colors.
- g. Flame Test Certification:
 - 1) NFPA 701 Small Scale
 - 2) NFPA 701 Test Method #01
 - 3) California Title 19
- h. Acoustical Noise Reduction / Sound Absorption:
 - 1) Noise Reduction Coefficient: 1.00
 - 2) Sound Absorption Average: 1.00
- 4. Lining Fabric:
 - a. Product: Basis of Design is Showstopper Lining Fabric IFR Acoustical weight as offered by Northeast Stage.
 - b. Fabric Width: 72 inch
 - c. Fabric Weight: 15 oz per linear yard.
 - d. Flame Retardant: Inherently flame retardant (IFR)
 - e. Fabric Content: 100% Polyester
 - f. Flame test Certifications:
 - 1) NFPA 701 Test Method #01
 - g. Color: As selected by Architect from manufacturer's full line of standard and premium colors.
- 5. Tiebacks: Match Drapery.
- 6. Hem Weights: 1-inch- (25-mm-) square lead weights.

2.04 DRAPE FABRICATION

- A. Fabricate drapes in heading styles and fullnesses indicated. Fabricate headings to stand erect. If less than a full width of fabric is required to produce panel of specified fullness, use equal widths of not less than one-half width of fabric located at ends of panel.
 - 1. Center-Opening Drapes: Add 10 inches to overall width for overlap.
- B. Seams: Sew vertical seams with twin-needle sewing machine with selvage trimmed and overlocked. Join widths so that patterns match and vertical seams lay flat and straight without puckering. Horizontal seams are unacceptable.
- C. Side Hems: Double-turned, 1-1/2-inch- (38-mm-) wide hems consisting of three layers of fabric, and blindstitched so that stitches are invisible on face of drape.
- D. Temporarily hem drapes at initial installation, with final hemming at the end of 6 months to accommodate stretch over 1 complete heating and cooling cycle.
- E. Bottom Hems: Double-turned, 4-inch- (102-mm-) wide hems consisting of three layers of fabric, and weighted and blindstitched so that weights and stitches are invisible on face of drape.
 - 1. Sew in square lead weights at each seam and at panel corners.
- F. Interlinings: Extend from top of drape to within 1/2 inch of lining's bottom hem and to leading edge of side hems to produce full-shadowed appearance.
- G. Linings: Equal to widths of drapery fabric and joined to drapery fabric at top by inside invisible seam, and hand stitched at side hems and shadowed with 1-1/2-inch (38-mm) return of face fabric.
 - 1. Bottom Hem: Blind stitch to drapery fabric.

PART 3 EXECUTION

3.01 DRAPERY ROD INSTALLATION

- A. Install track systems according to manufacturer's written instructions, level and plumb, and at height and location in relation to adjoining openings as indicated on Drawings.
- B. Isolate metal parts of tracks and brackets from concrete, masonry, and mortar to prevent galvanic action. Use tape or another method recommended in writing by track manufacturer.

3.02 DRAPE INSTALLATION

- A. Where drapes abut overhead construction, hang drapes so that clearance between headings and overhead construction is 1/4 inch.
- B. Where drapes extend to floor, install so that bottom hems clear finished floor by not more than 1 inch and not less than 1/2 inch.
- C. Where drapes extend to windowsill, install so that bottom hems hang above sill line and clear sill line by not more than 1/2 inch.

3.03 ADJUSTING

- A. After hanging drapes, test and adjust each drapery track to produce unencumbered, smooth operation.
- B. Steam and dress down drapes as required to produce crease- and wrinkle-free installation.
- C. Remove and replace drapes that are stained or soiled.
- D. Schedule return with Owner to complete final hemming.

END OF SECTION 12 2200

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SECTION 13 4800
ACOUSTIC DOOR AND FRAME SYSTEM

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- B. ASTM E336 - Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings; 2023.
- C. ASTM E413 - Classification for Rating Sound Insulation; 2022.

1.02 SUMMARY

- A. Provide sound control door and frame assemblies where shown on the Drawings, as specified herein, and listed on the Door Schedule. The work includes door and frame assemblies complete with acoustical seals, cam-lift hinges, and all finish hardware factory supplied and installed. Door leaf and frame is factory assembled and shipped complete as one unit.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Sound Rating: Provide door and frame assemblies that have been fabricated as sound-retardant units, tested according to ASTM E90 and have the following certified Sound Transmission Class (STC) rating as determined according to ASTM E413.
 - 1. STC Rating 55 Unless otherwise indicated on Drawings.

1.04 SUBMITTALS

- A. Comply with pertinent provisions of the Contract and Division 1.
- B. Product Data: Within 30 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Material lists of items provided under this Section.
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
 - 3. Shop Drawings showing details of each frame type, elevations of door designs, details of openings, and details of construction, installation and anchorage.
 - 4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.
 - 5. Test Reports from a qualified independent testing agency indicating and interpreting test results from Part 3 of this Section relative to compliance of sound ratings with the indicated requirements.
 - 6. Material certificates in lieu of laboratory test reports when permitted by Architect signed by the manufacturer certifying that each sound control door complies with the project requirements,
- C. Photographs and quality control inspection reports will be provided prior to shipment. Photograph including doors with all pertinent hardware installed and hanging, in the completed position. Door open and door closed photographs will be provided for each door.

1.05 QUALITY ASSURANCE

- A. Acoustical Performance
 - 1. The acoustical door manufacturer will be required to submit acoustical performance data in the form of up-to-date test reports from an independent testing laboratory indicating the doors to be provided will have the required sound transmission class rating (ASTM E90-90).
 - 2. For the required STC rating, refer to door schedule drawing.
 - 3. Owner may at his option order performance tests of installed window assemblies by an independent consultant to verify compliance with the specifications. Any discrepancies shall be repaired or replaced without cost to the Owner.

- B. Single-Source Responsibility: Provide sound control doors and frames, including gaskets, hinges and other hardware items essential for sound control as an assembly and by a single firm specializing in producing this type of work for a minimum of ten (10) years.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Use all means necessary to protect the materials of this section before, during and after installation and to protect the installed work and materials of all other trades.

1.07 WARRANTY

- A. Acoustic door materials and hardware shall be guaranteed against defective workmanship for one (1) year from date of shipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Provide Basis of Design or approved equal product.
- B. Basis of Design is single leaf, "Noise Lock" acoustic door(s) and frame(s) with cam lift hinges and split frames as manufactured by IAC Acoustics, A Division of Sound Seal 401 Airport Road, North Aurora, IL 60542 630-270-1790. Equivalent products will be considered, when submitted for approval prior to the bid opening, and meet or exceed the requirements of this specification.

2.02 MANUFACTURED ASSEMBLIES (NOISE LOCK DOORS)

- A. Door leaf minimum thickness: STC 55 Rating, 3 1/2" (3.5 inch)
 - 1. Door leaf(s) and door stiffeners are to be fabricated from 14 gauge (0.08 inch) cold rolled, galvanized steel with an A60 coating weight, and filled with 6 lb density, sound absorbing, and damping elements.
- B. Frame(s) shall be fabricated from 14 gauge cold rolled, galvanized steel with an A60 coating weight and furnished "split" in two (2) pieces, inside and outside, that are mitered and welded together allowing for easy installation into either existing or new construction openings.
- C. Acoustic seals: Doorjamb, meeting stiles of double doors and at the head of the door and frame shall receive self-aligning magnetic, fire resistant (if UL rated) compression seals. Door(s) to be held in closed position by magnetic force of perimeter seals.
 - 1. Acoustic labyrinth shall be created when door is in closed position. Bottom of door leaf shall contain continuous, adjustable, gravity-activated seal that shall compress against the floor as the door is closed. Raised sills and threshold drop seals will not be acceptable.
 - 2. Acoustic Seal assemblies STC 55 Rating, Double Magnetic type
- D. Jamb anchors: Provide jamb anchors as determined by wall construction. Anchors are to be spaced at 12" (12.01 inch) on center (max) and are to be of a corrosion resistant material.
 - 1. Hardware
 - 2. Hinges: IAC, cam-lift, butt-type, hinges, US26D finish (Hinge manufacturer to furnish laboratory test data certifying that hinges of identical design have been cycled a minimum of 125,000 times while supporting a door leaf weighing a minimum of 350 lbs.).
 - a. Quantities of hinges as follows:
 - 1) For door leaf thickness greater than 2 1/2" (64):
 - (a) Three (3) hinges required per leaf for openings up to and including 96" (95.98 inch) high
 - 3. Closers: "LCN" or "Norton", factory installed.
 - 4. Pull Handles: 1" (0.98 inch) diameter x 9" (9.02 inch) overall length, 3" (2.99 inch) projection, US28 finish, factory installed.
 - 5. Push Plates: 4" (4.02 inch) wide x 16" (15.98 inch) high x .050" (0.04 inch) thick, US32D finish, factory installed.
 - 6. Latchsets/Locksets: Provided and installed by door manufacturer. Refer to finish hardware section for manufacturer, type and details.
 - 7. Exit Devices: Provided and installed by door manufacturer. Refer to finish hardware section for manufacturer, type and details.

- E. Hardware Reinforcement:
 - 1. Hinges: Minimum of ¼" ([0.24] inch) thick x 2" ([2.01] inch) wide x 7 ½" ([7.52] inch) lg.
 - 2. Frames: Minimum of 3/16" ([0.2] inch) thick for strikes and #11 ([0.12] inch) gauge for closers.
 - 3. Doors: Minimum of #11 ([0.12] inch) gauge for lock boxes and closers.
- F. Glazing
- G. Non-Fire Rated: Provide factory-installed, aluminum extruded stops and moldings with true mitered corners for double, glazed assemblies. Size of vision lite is to be determined from the door schedule. Safety glass or fire-resistive glazing product meeting doors' sound control and labeling requirements is acceptable.

2.03 PRE-HUNG

- A. Assembly and adjustment of door leaf, frame, acoustic seals, hinges and associated finish hardware shall take place at the factory to insure ease of installation, reliable operation and acoustic performance. The entire manufactured assembly shall be shipped to the job site ready to install and operate.

2.04 FABRICATION

- A. General: Fabricate units to be rigid, neat in appearance and free from defects, warp or buckle. Accurately form metal to required sizes and profiles. Wherever practical, fit and assemble units in the manufacturer's plant. Identify work that is not permanently factory-assembled before shipment to ensure proper assembly at the Project site. Weld exposed joints continuously: grind, fill dress and make smooth flush and invisible.

2.05 FINISHES (FACTORY)

- A. Doors and frames shall receive a shop coat of a rust-inhibitive primer. The primer shall be applied over properly prepared metal, in accordance with the manufacturer's standard shop prime coat procedure and oven-baked dry.
- B. Paper-backed, wood veneer shall be applied as a finish, on both side(s) of the doors. Color and pattern to be selected by Architect from Manufacturers full range of standard and premium colors.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions.

3.02 PREPARATION

- A. Adjacent Surfaces Protection: Protect adjacent work areas and finish surfaces from damage during product installation.
- B. Adjacent Construction: Coordinate door assembly details with details of adjacent work to ensure proper attachments and clean junctions.

3.03 INSTALLATION

- A. Install work in accordance with reviewed shop drawings and these specifications using only factory-trained personnel as required by the Manufacturer and approved by the Architect.
 - 1. Hang doors and adjust for free swinging operation without binding, sticking, sagging or excessive clearances.
 - 2. During installation, solidly pack acoustic insulation around frames that are installed in stud and gypsum-wallboard partitions.
 - 3. Caulk exterior joint prior to painting.
 - 4. Install sound control door assemblies during finish phase of construction to protect units from damage.
 - 5. When installation is otherwise complete, adjust operating hardware for proper operation and function.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of this portion of work, and prior to its acceptance by the Owner, secure a visit to the job site by a qualified representative of the manufacturer of the acoustical door system(s) to confirm that installation is in conformance with the manufacturer's recommendations.

3.05 DEMONSTRATION

- A. Instruct the Owner's maintenance personnel regarding operation and maintenance of all acoustic doors.

END OF SECTION 13 4800

**SECTION 13 4801
ACOUSTIC WINDOW**

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- B. ASTM E336 - Standard Test Method for Measurement of Airborne Sound Attenuation Between Rooms in Buildings; 2023.
- C. ASTM E413 - Classification for Rating Sound Insulation; 2022.

1.02 SUMMARY

- A. Provide sound control window assemblies where shown on the Drawings, as specified herein, and listed on the Window Schedule. The work includes window assemblies complete with frames, stops, glazing, sound-absorbing material and concealed fasteners factory installed. Glass and glazing material are factory assembled in frame and shipped complete as one unit.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Sound Rating: Provide window assemblies that have been fabricated as sound-retardant units, tested according to ASTM E90 and have the following certified Sound Transmission Class (STC) rating as determined according to ASTM E413.
 - 1. STC Rating 55 unless otherwise indicated.

1.04 SUBMITTALS

- A. Comply with pertinent provisions of the Contract and Division 1.
- B. Product Data: Within 30 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Material lists of items provided under this Section.
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
 - 3. Shop Drawings showing details of each frame type, elevations of door designs, details of openings, and details of construction, installation and anchorage.
 - 4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.
 - 5. Test Reports from a qualified independent testing agency indicating and interpreting test results from Part 3 of this Section relative to compliance of sound ratings with the indicated requirements.
 - 6. Material certificates in lieu of laboratory test reports when permitted by Architect signed by the manufacturer certifying that each sound control window complies with the project requirements.

1.05 QUALITY ASSURANCE

- A. Acoustical Performance
 - 1. The acoustical window manufacturer will be required to submit acoustical performance data in the form of up-to-date test reports from an independent testing laboratory indicating the windows to be provided will have the required sound transmission class rating (ASTM E90).
 - 2. Owner may at his option order performance tests of installed window assemblies by an independent consultant to verify compliance with the specifications. Any discrepancies shall be repaired or replaced without cost to the Owner.
- B. Single-Source Responsibility: Provide sound control windows, including stops, glazing, frame and sound-absorbing material essential for sound control as an assembly and by a single firm specializing in producing this type of work for a minimum of ten (10) years.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Use all means necessary to protect the materials of this section before, during and after installation and to protect the installed work and materials of all other trades.

1.07 WARRANTY

- A. Acoustic window materials and associated hardware shall be guaranteed against defective workmanship for one (1) year from date of shipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Provide Basis of Design or approved equal product.
- B. Basis of Design is double glazed, "Noise Lock" acoustic window(s) and frame(s) with stops, glazing, sound-absorbing material, and concealed fasteners as manufactured by IAC Acoustics, A Division of Sound Seal 401 Airport Road, North Aurora, IL 60542. (630)-270-1790. Equivalent products will be considered, when submitted for approval prior to the bid opening, and meet or exceed the requirements of this specification.

2.02 MANUFACTURED ASSEMBLIES (NOISE LOCK WINDOWS)

- A. Glass pane(s) minimum thickness:
 - 1. STC 55 Rating, 1/2" (0.50 inch) interior, 1/4" (0.25 inch) exterior – double pane
 - 2. Glass type shall be:
 - a. 1/2" Laminated Safety Glass
- B. Frame(s) shall be 1 1/4" thick, fabricated from not less than 12 gauge cold rolled, galvanized steel with an A60 coating weight, reinforced and filled with sound-absorbing acoustic fill. Inside and outside corners shall be mitered and interlocked to hairline measurements, made square, continuously welded, and ground smooth, flush and invisible. The window assembly can be installed into either existing or new construction openings.
- C. Acoustic seals for glazing shall be vibration-isolating resilient gaskets, U-shaped and continuous santoprene UV grade 65-75 durometer black. Self-contained, sound absorptive interior perimeter of not less than 22 gauge (0.03 inch) steel shall be perforated and pre-finished black. Desiccant material shall be incorporated into multiple glazed units.
- D. Stops: Provide stops that are 1" (0.98 inch) high (min) and readily removable, fabricated from not less than 16 gauge (0.08 inch) rolled steel sections predrilled and aligned with frame to form tight square acoustical joints. Stop fasteners shall be concealed.
- E. Assembly: The assembly of the acoustic window units including frames, stops, glazing, acoustic seals, sound-absorbing material and concealed fasteners shall take place at the factory to insure required noise reduction is achieved. Glazing shall not need to be removed to facilitate fastening or anchoring at the job site.

2.03 FABRICATION

- A. General: Fabricate units to be rigid, neat in appearance and free from defects, warp or buckle. Accurately form metal to required sizes and profiles. Wherever practical, fit and assemble units in the manufacturer's plant. Identify work that is not permanently factory-assembled before shipment to ensure proper assembly at the Project site. Weld exposed joints continuously: grind, fill dress and make smooth flush and invisible.

2.04 FINISHES (FACTORY)

- A. Frames shall receive a shop coat of a rust-inhibitive primer. The primer shall be applied over properly prepared metal, in accordance with the manufacturer's standard shop prime coat procedure and oven-baked dry.
- B. Others, as required, will perform finish painting, under the painting section 09 9123 - Interior Paint of this Specification.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions.

3.02 PREPARATION

- A. Adjacent Surfaces Protection: Protect adjacent work areas and finish surfaces from damage during product installation.
- B. Adjacent Construction: Coordinate window assembly details with details of adjacent work to ensure proper attachments and clean junctions.

3.03 INSTALLATION

- A. Install work in accordance with reviewed shop drawings and these specifications using only factory-trained personnel as required by the Manufacturer and approved by the Architect.
 - 1. Install windows and shim accordingly to allow for a plumb and square installation without excessive clearances.
 - 2. During installation, solidly pack acoustic insulation around frames that are installed in stud and gypsum-wallboard partitions.
 - 3. Caulk exterior joint prior to painting.
 - 4. Install sound control window assemblies during finish phase of construction to protect units from damage.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of this portion of work, and prior to its acceptance by the Owner, secure a visit to the job site by a qualified representative of the manufacturer of the acoustical door system(s) to confirm that installation is in conformance with the manufacturer's recommendations.

3.05 DEMONSTRATION

- A. Instruct the Owner's maintenance personnel regarding the maintenance of all acoustic windows.

END OF SECTION 13 4801

SECTION 22 0000
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END OF SECTION 22 0000

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SECTION 22 0010
GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 22 of the Specifications and Drawings numbered with prefixes, Mor ME generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.02 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.03 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code – 2021____
IMC	International Mechanical Code – 2021____
IPC	International Plumbing Code – 2021____
IECC	International Energy Conservation Code – 2018____
ADA	American Disabilities Act
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Airc Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.04 DEFINITIONS

A. General:

1. **Furnish:** When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
2. **Install:** The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. **Provide:** The term "provide" means "to furnish and install, complete and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. 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.
 - b. 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.
9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.05 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The Contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The Contractor shall inform the Architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The Contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.
- D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

- E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.06 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of 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 trade.
 - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
 - 4. Indicate required installation sequence to minimize conflicts between entities.
 - 5. 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 Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 - 6. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

1.08 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the

Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.
- M. Provide welders' qualification certificates.

1.09 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check

made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
 - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 - 2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
 - 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 - 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain data listed in Table 5.
- F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 2 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.
- B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or

damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

- D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

1.15 GUARANTEES AND WARRANTIES

- A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
- C. The following additional items shall be guaranteed:
1. Piping shall be free from obstructions, holes or breaks of any nature.
 2. Insulation shall be effective.
 3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.16 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings:
1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting their bid to determine the nature and extent of work involved.
 2. Work in the existing building shall be scheduled with the Owner.
 3. Certain demolition work must be performed prior to the remodeling. The Plumbing Contractor shall perform the demolition which involves Plumbing and Plumbing systems, fixtures, equipment, piping, equipment supports or foundations and materials.
 4. Plumbing Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Plumbing Contractor during this demolition shall become their property and shall be removed by the Plumbing Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
 5. Plumbing Contractor shall relocate and reconnect Plumbing facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Plumbing equipment or materials are removed, the Plumbing Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
 6. General Contractor shall install finish material.
 7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
 8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect Plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

PART 3 - EXECUTION

3.01 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.02 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned Plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing Plumbing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- E. Plumbing Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 1. Inactive and obsolete piping, fittings and specialties, equipment, controls, fixtures and insulation.
 - a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 22.
- F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.03 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.
- G. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.04 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.05 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 - 1. Submit complete Operation and Maintenance Manuals.
 - 2. Submit complete Record Drawings.
 - 3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 22 that contain special inspection requirements.
 - 4. Start-up testing of systems.
 - 5. Removal of temporary facilities from the site.
 - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, The Contractor shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 22 0010

TABLE 1: PLUMBING SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

<u>SPECIFICATION NUMBER/TITLE</u>		<u>CODE DESIGNATION</u>
220010	General Plumbing Requirements	NONE
220500	Common Work Results For Plumbing	A, B, G, M
220515	Basic Piping Materials And Methods	B, G
220523	General-Duty Valves For Plumbing Piping	B
220529	Hangers And Supports For Plumbing Piping	B, F, G, H
220553	Identification For Plumbing Piping & Equipment	B, L, M
220700	Plumbing Insulation	B, M
221100	Water Distribution Piping & Specialties	B, G, H
221300	Sanitary Drainage & Vent Piping & Specialties	B

CODED LEGEND

A	Shop Drawings
B	Product Data and equipment weights
C	Performance Data, Curves, Certificates and Test Data
D	Coordination Drawings
E	Wiring Diagrams and short circuit current ratings
F	Installation Instructions
G	Welder's Certificates
H	Certificates
I	Calculations
J	Special Inspections
K	Special Warranties
L	Material Samples
M	Schedules
N	Recommended Spare Parts List

TABLE 2: SPARE PARTS REQUIREMENTS FOR PLUMBING EQUIPMENT

<u>SECTION NUMBER</u>		<u>RECEIVED/DATE/INITIAL</u>
220553	Identification For Plumbing Piping & Equipment	_____
221100	Water Distribution Piping & Specialties	_____

Owner's Signature

TABLE 5: PLUMBING SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

<u>SPECIFICATION NUMBER/TITLE</u>		<u>CODE DESIGNATION</u>
220500	Common Work Results For Plumbing	B
220515	Basic Piping Materials And Methods	B
220523	General-Duty Valves For Plumbing Piping	B, H, I
220529	Hangers And Supports For Plumbing Piping	B
220553	Identification For Plumbing Piping & Equipment	B
220700	Plumbing Insulation	B
221100	Water Distribution Piping & Specialties	A, B, F, H, I
221300	Sanitary Drainage & Vent Piping & Specialties	A, B, F

CODED LEGEND

A	As-Built Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Wiring Diagrams
E	Operating Instructions
F	Test Reports
G	Warranties
H	Recommended Spare Parts List
I	Service and Maintenance Instructions

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples
☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No	
Additional Comments:	☐ Attached	☐ None	

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

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SECTION 22 0500
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:
 - 1. Access panels and doors in walls, ceilings, and floors for access to Plumbing materials and equipment.
 - 2. Sleeves for Plumbing penetrations.
 - 3. Miscellaneous metals for support of Plumbing materials and equipment.
 - 4. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.
 - 5. Joint sealers for sealing around Plumbing materials and equipment.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 22 Section "Basic Piping Materials and Methods" for materials and methods for mechanical sleeve seals.
 - 3. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for indirect drain piping and installation requirements.
 - 4. Division 26 Section "Common Work Results for Electrical" required electrical devices.
 - 5. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.02 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 22 Section "General Plumbing Requirements".
 - 1. Product data for the following products:
 - a. Access panels and doors.
 - b. Through and membrane-penetration firestopping systems.
 - c. Joint sealers.
 - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.
 - 3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
 - 4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."
 - 5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit

illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.
- C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.04 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

<u>Space</u>	<u>RC Levels</u>
Broadcast Studio	25

1.05 ACCESS TO EQUIPMENT

- A. Manufacturer:
 - 1. Bar-Co., Inc.
 - 2. Elmdor Stoneman.
 - 3. JL Industries
 - 4. Jay R. Smith Mfg. Co.
 - 5. Karp Associates, Inc.
 - 6. Milcor
 - 7. Nystrom Building Products
 - 8. Wade
 - 9. Zurn
- B. Access Doors:
 - 1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Plumbing Piping" for labeling of access doors.
 - 2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
 - 3. Access doors must be of the proper construction for type of construction where installed.
 - 4. The exact location of all access doors shall be verified with the Architect prior to installation.

5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
8. Locking Devices: Flush, screwdriver-operated cam locks.
9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

1.06 GROUT

- A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.
- B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.
- C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

1.07 PENETRATIONS

- A. Sleeves:
 1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
- B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.
- C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

1.08 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.

- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

1.09 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPB rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

1.10 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
 - a. "Dow Corning 790," Dow Corning Corp.
 - b. "Silglaze II SCS 2801," General Electric Co.
 - c. "Silpruf SCS 2000," General Electric Co.
 - d. "864," Pecora Corp.
 - e. "Rhodia 5C," Rhone-Poulenc, Inc.
 - f. "Spectrem 1," Tremco, Inc.
 - g. "Spectrem 2," Tremco, Inc.
 - h. "Dow Corning 795," Dow Corning Corp.
 - i. "Rhodia 7B," Rhone-Poulenc, Inc.
 - j. "Rhodia 7S," Rhone-Poulenc, Inc.
 - k. "Omniseal," Sonneborn Building Products Div.
 - 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
 - a. "Dow Corning 786," Dow Corning Corp.
 - b. "Sanitary 1700," General Electric Co.
 - c. "898 Silicone Sanitary Sealant," Pecora Corp.
- D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600," Bostik Construction Products Div.
 - b. "AC-20," Pecora Corp.
 - c. "Sonolac," Sonneborn Building Products Div.
 - d. "Tremflex 834," Tremco, Inc.

1.11 ACOUSTICAL SEALANTS

- A. General: Penetrations by pipes through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
- B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.
- C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
- D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m3).

1.12 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:
 - 1. 3M Corp., Fire Barrier Sealant
 - 2. Hilti
 - 3. Owens Corning, Firestopping Insulation.
 - 4. Pecora, AC-20 FTR
 - 5. RectorSeal
 - 6. Specified Technologies Inc.,
 - 7. United States Gypsum Company SHEETROCK Firecode Compound
 - 8. Tremco, Tremstop Fyre-Sil.

PART 2 - EXECUTION

2.01 INSTALLATION, GENERAL

- A. Install access doors and sealants in accordance with manufacturer's installation instructions.

2.02 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

2.03 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

2.04 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

2.05 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

2.06 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

2.07 PENETRATIONS:

- A. Construction in Existing Facilities:
 - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
- B. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.
- C. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.
- D. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.
- E. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- I. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.
- J. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section "Basic Piping Materials and Methods".

2.08 ACOUSTICAL PENETRATIONS

- A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the plumbing equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.
- B. Domestic Water, Sewer, Drain and Vent Piping
 - 1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the

piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION 22 0500

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SECTION 22 0515
BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Common Work Results for Plumbing" for materials and methods for sleeve materials.

1.02 DEFINITIONS

- A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.03 SUBMITTALS

- A. Refer to Division 01 and Division 22 Section "General Plumbing Requirements" for administrative and procedural requirements for submittals.
- B. Product Data: Submit product data on the following items:
 - 1. Dielectric Unions
- C. Quality Control Submittals:
 - 1. Submit welders' certificates specified in Quality Assurance below.
- D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.
- E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.
- F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.04 QUALITY ASSURANCE

- A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.
- C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.
- D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:
 - 1. Pipe Escutcheons:
 - a. AWI Manufacturing.
 - b. Keeney Manufacturing Company
 - c. Wal-Rich Corp.
 - d. Jones Stephens Corp.
 - 2. Dielectric Unions:
 - a. JOMAR International
 - b. Smith Cooper International
 - c. Watts Regulator Co.
 - d. Zurn Industries

2.02 PIPE AND FITTINGS

- A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

- A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.
- B. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
- D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

2.04 PIPING SPECIALTIES

- A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated and of depth adequate to conceal protruding piping. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
- B. Unions:
 - 1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
 - 2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.
- C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

- D. Sleeves:
 - 1. Sleeve: Refer to Division 22 Section "Common Work Results for Plumbing" for sleeve materials.
- E. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.

3.02 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.03 INSTALLATIONS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
- C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- I. Verify final equipment locations for roughing in.

3.04 PIPING PROTECTION

- A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.05 PENETRATIONS

- A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

- B. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe , using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - 1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
- C. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.
- D. Acoustical Barrier Penetrations: Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. The internal diameter of the sleeve shall be a minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.
 - 1. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.06 FITTINGS AND SPECIALTIES

- A. Use fittings for all changes in direction and all branch connections.
- B. Remake leaking joints using new materials.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install dielectric unions for piping 2" and smaller to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.
- E. Install dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.

3.07 JOINTS

- A. Steel Pipe Joints:
 - 1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
 - 2. Pipe Larger Than 2":
 - a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
 - b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
 - c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

- B. Non-ferrous Pipe Joints:
 - 1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.
 - 2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
- C. Joints for other piping materials are specified within the respective piping system Sections.

3.08 PIPE FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.
- B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

END OF SECTION 22 0515

PLUMBING & PLUMBING PIPING SYSTEMS
INSPECTION REPORT FORM

Project Name: _____
Project No: _____ Contractor Project No. _____
General Contractor: _____
Inspection Date: _____ Temperature: _____

System Inspected

Building: _____
Location/Description: _____
Service: _____

Inspection Results

Time of Inspection: _____
Approval to Insulate: Y N Approval to Cover in Wall: Y N
Approval to backfill Y N

Signatures

Witness: _____ Representing: _____
Witness: _____ Representing: _____
Witness: _____ Representing: _____

Remarks

Contractor Supervisor's signature: _____

SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components.
- B. Horizontal-piping hangers and supports.
- C. Shields
- D. Anchors and fasteners.
- E. Miscellaneous materials.
- F. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Plumbing Insulation", for high density insulation for protecting insulation vapor barrier and materials and methods for piping hanger installations.
 - 2. Division 22 "Water Distribution Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical domestic water distribution and heat traced piping of sizes and materials indicated.
 - 3. Division 22 "Sanitary Drainage & Vent Piping and Specialties", for pipe hanger types and spacing for heat traced and cold sanitary piping of sizes and materials indicated.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 2. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 3. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.03 SUBMITTALS

- A. Product Data : Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.
- B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.
- C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 22 Section "General Plumbing Requirements".
- E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.

1. Application of protective inserts, and shields at pipe hangers for each type of insulation and hanger.
- F. Installer's Qualifications: Include evidence of compliance with specified requirements.
- G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Field-Welding:
 1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
 3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."
- D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.06 DEFINITIONS

- A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS AND MATERIALS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 1. Comply with MSS SP-58.
 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.

- b. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
 - e. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.
- B. Metal Channel (Strut) Framing Systems:
 - 1. Manufacturers:
 - a. Cooper B-Line.
 - b. Ferguson Enterprises/FNW.
 - c. PHD Manufacturing.
 - d. Thomas & Betts Corporation.
 - e. Unistrut, a brand of Atkore International Inc.
 - f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.
 - 4. Channel Material:
 - a. Indoor Dry Locations: Galvanized steel or zinc-plated steel.
 - b. All nuts, brackets, and clamps shall have the same finish as the channel.
 - 5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.
 - 6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.
 - 7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.
- C. Hanger Rods:
 - 1. Material:
 - a. Indoor Dry Locations: Zinc-plated steel.
 - 2. Threaded both ends or continuously threaded.
 - 3. Minimum Size: Reference piping specification sections for rod thicknesses.
 - 4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.02 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. MANUFACTURERS
 - 1. ASC Engineered Solutions.
 - 2. Cooper B-Line, Inc.
 - 3. Elite Components
 - 4. ERICO/Michigan Hanger Co./Caddy
 - 5. Ferguson/FNW.

6. Halfen-DEHA.
 7. Hilti.
 8. National Pipe Hanger Corporation.
 9. PHD Manufacturing.
 10. Power-Strut.
 11. Unistrut.
- B. Single Hangers:
1. Split Ring: Carbon steel, adjustable swivel, split ring type.
 2. Split Ring 2 inch and smaller: Copper alloy, split ring type.
 3. Clevis Hanger: Carbon steel, adjustable, clevis type.
 4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.
- C. Trapeze and Strut-mounted Supports:
1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
 2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.
- D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:
1. Manufacturers:
 - a. ASC Engineered Solutions.
 - b. Holdrite.
 - c. Klo-Shure.
 2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.
- E. Spring Hangers:
1. Reference Section "Vibration Isolation for Plumbing Piping and Equipment" for spring isolation hangers.
- F. Wall Supports:
1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.
 2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.
- G. Pre-Insulated Supports:
1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. ASC Engineered Solutions
 - c. Armacell.
 - d. Buckaroos, Inc.
 - e. Cooper B-Line, Inc.
 - f. Pipe Shields, Inc.

2. General Construction and Requirements:
 - a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.
 - b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Waterproof calcium silicate insulation shall conform to ASTM C795.
 - d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.
 - e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.
3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.03 SHIELDS

A. Insulation Protection Shield:

1. Sheet metal construction, meeting SP-58 Type 40, of 18 gauge for 5-1/2" inside dimension and smaller, 16 gauge for 6-1/2" to 10-3/4" inside dimension 14 gauge for 11-3/4" to 17" inside dimension, and 12 gauge for 18" to 28" inside dimension.
2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
4. For pipes 2 inch and smaller using fiberglass or flexible elastomeric insulation without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in)					
		Hanger Spacing, (ft)					
		5	6	7	8	9	10
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
≤ 2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

- B. 360° Insulation Protection Shield: Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Plastic Shields:
 1. Manufacturers:
 - a. Armacell.
 - b. Eaton.
 - c. Hydra-Zorb.
 - d. PHD Manufacturing.
 - e. Zsi Foster.
 2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.04 ANCHORS AND FASTENERS

- A. Manufacturers:
 - 1. Hilti, Inc.
 - 2. Illinois Tool Works, Inc.
 - 3. Phillips.
 - 4. Powers Fasteners, Inc.
 - 5. Rawl.
 - 6. Simpson Strong-Tie Company Inc.
- B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 1. Concrete: Use preset concrete inserts or expansion anchors.
 - 2. Solid or Grout-Filled Masonry: Use expansion anchors.
 - 3. Hollow Masonry: Use toggle bolts.
 - 4. Hollow Stud Walls: Use toggle bolts.
 - 5. Steel: Use beam clamps.
 - 6. Sheet Metal: Use sheet metal screws.
 - 7. Wood: Use wood screws.
 - 8. Plastic and lead anchors are not permitted.
 - 9. Hammer-driven anchors and fasteners are permitted only as follows:
 - a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
 - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.
- D. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - 1. Comply with MFMA-4.
 - 2. Channel Material: Use galvanized steel.
 - 3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
 - 4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rod dimensions.
 - 5. Manufacturers:
 - a. Same as manufacturer of metal channel (strut) framing system.
 - b. DeWalt "Bang-It" concrete inserts.
- E. Post-Installed Concrete and Masonry Expansion Anchors:
 - 1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 - 2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.
- F. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.
 - 1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 - 2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

- G. Vibration Isolation Anchors: Reference Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for vibration isolation anchors.

2.05 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Malleable Iron: ASTM A47
- H. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION, GENERAL

- A. Install hangers and supports in accordance with manufacturer's installation instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

3.03 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.
- B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- C. Space attachments within maximum piping span length specified in Division 22 piping sections.
- D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- E. Install hangers, supports, clamps and attachments to support piping properly from building structure.
- F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.
- G. Hanger and clamps sizing:
 - 1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
 - 2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.
 - 3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.

4. Refer to Division 22 Section "Plumbing Insulation" for definition of hot and cold piping and required insulation thickness.
- H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 22 piping sections.
 1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
 2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
 - a. Uninsulated Copper Pipe: Install with plastic galvanic isolators
 - b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".
- I. Install building attachments within concrete or to structural steel.
 1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 22 piping sections.
 2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.
- K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
 1. Riser Clamps: Attach riser clamps to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section "Plumbing Insulation".
 - a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert for cold piping 2-1/2 inches and larger.
 2. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section "Plumbing Insulation". Do not use polymer-based shields for hot piping.
 - a. Exception for horizontal cold-piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.
 3. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.
 4. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
- O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide

channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".

P. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.

3.04 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.05 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.06 FIELD QUALITY CONTROL

- A. Examine support and attachment components for damage and defects.
- B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."
 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.
- F. Correct deficiencies and replace damaged or defective support and attachment components.

3.07 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

- B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:
- C. Single Hangers:
 - 1. All pipe sizes 1-1/2 inch and less:
 - a. Band hanger.
 - b. Swivel split ring.
 - c. Clevis hanger.
 - 2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.
 - 3. Cold and Hot pipe sizes 6 inches and greater: Roll support hanger.
 - 4. All drainage pipe sizes: Clevis hanger.
- D. Trapezes and Strut-mounted Supports:
 - 1. All pipe sizes less than 6 inches: Two-piece clamp.
 - 2. Pipe sizes 6 inches and greater: Roll support.
- E. Wall Supports:
 - 1. Pipe sizes 3 inches and less:
 - a. Two-hole strap mounted to wall.
 - b. Welded steel bracket with reinforced angle or strut.
 - 2. Pipe sizes 4 inch and greater:
 - c. U-bolt
 - d. Welded steel bracket with reinforced angle or strut.

END OF SECTION 22 0529

SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.
- B. Types of identification devices specified in this Section include the following:
 - 1. Plastic Pipe Markers
 - 2. Plastic Tape

1.02 CODES AND STANDARDS:

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
- D. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section "General Plumbing Requirements."

1.04 SPARE PARTS

- A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 - 1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:
 - 1. Advanced Graphic Engraving, LLC.
 - 2. Brady Co.
 - 3. Brimar Industries, Inc.
 - 4. Craftmark.
 - 5. Kolbi Pipe Marker Co.
 - 6. Seton

2.02 PLUMBING IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.03 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1
- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - 2. Adhesive lap joint in pipe marker overlap.
 - 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".
- E. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - 1. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 - 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
- G. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
- H. Lettering: Comply with piping system nomenclature as specified, scheduled, or shown, and abbreviate only as necessary for each application length.

2.04 PLASTIC TAPE

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Application: Provide piping system identification for the following systems:
 - 1. Domestic cold water piping.
 - 2. Domestic hot water piping.
 - 3. Domestic hot water recirculating piping.
 - 4. Sanitary and waste piping.
 - 5. Storm water piping.
 - 6. Vent piping.
- C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.
 - 2. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.
 - 3. At access doors, manholes and similar access points which permit view of concealed piping.
 - 4. Within 5 feet of major equipment items and other points of origination and termination.
 - 5. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

END OF SECTION 22 0553

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SECTION 22 0700
PLUMBING INSULATION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

- A. Piping Insulation.

1.02 RELATED REQUIREMENTS

- A. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields and high-density insulation inserts.

1.03 DEFINITIONS

- A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.
- B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.
- C. Exposed: Insulation that is visible from the occupied space.
- D. NAIMA: North American Insulation Manufacturers Association

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of Plumbing insulation.
- B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of Plumbing insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Flame/Smoke Ratings: Provide composite plumbing insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.01 PIPING INSULATION MATERIALS

- A. Mineral Fiber (rock, slag, or glass):
 - 1. Manufacturers:
 - a. Knauf Insulation
 - b. Johns Manville
 - c. Owens Corning
 - 2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.
 - a. K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.
 - b. Minimum Service Temperature: 0 degrees F
 - c. Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.
 - d. Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.
 - 3. Factory Applied Jacket: ASTM C1136, Type I.
 - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.
 - b. Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.
 - c. Color: White.
- B. Flexible Elastomeric:
 - 1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.
 - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 297 degrees F
 - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
 - 3. Factory Applied Jacket:
 - a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Jacket requirements in Part 3 of this specification for application of this jacket.
- C. Field-Applied Jacket:
 - 1. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
 - a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
 - b. Manufacturers:
 - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
 - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
 - 3) Or approved equal.

2. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in)		
	Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco

- a. Banding:
 - 1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
 - 2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.
3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
- D. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
 1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
 2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.
 3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
 4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in.	Insulation Permeability, 4.0 or greater perm-in.
	(Note 2)	(Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02

Notes:

5. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
6. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.
- F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

- H. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW.
 - 1. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - 2. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
- I. Pipe Insulation Accessories: Provide staples, Bands, Wires, and Cement and other appurtenances as recommended by insulation manufacturer for applications indicated.
- J. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- K. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 PROTECTION AND REPLACEMENT

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.
- B. Repair existing plumbing insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.
- C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.03 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

3.04 PLUMBING PIPING SYSTEM INSULATION

- A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Exposed Piping: Locate insulation and cover seams in least visible locations.
- E. Cold Piping Insulation:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Provide with factory applied vapor barrier jacket.
 - 3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers and

Supports for Plumbing Piping” for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 5. Secure all-service jacket with self-sealing longitudinal laps.
- F. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture infiltration.
- G. Hot Piping Insulation:
1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
 2. Provide jackets without vapor barrier. Jackets with factory applied vapor barrier are allowed.
 3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers and Supports for Plumbing Piping” for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 5. Secure all-service jacket with self-sealing longitudinal laps.
 6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

3.05 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.
- C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- E. Clean and dry pipe surfaces prior to insulating.
- F. Cold Pipe Insulation:
1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
 2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section “Hangers and Supports for Plumbing Piping” for pre-insulated supports.
 3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section “Hangers and Supports for Plumbing Piping” for insulation shields.
 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 5. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

- G. Hot Pipe Insulation:
 - 1. Provide pipe hangers for hot piping sized for the outside diameter of piping.
 - 2. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints. Seal exposed insulation at hanger with joint sealant.
- H. Pipe insulation:
 - 1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
 - 2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports.
 - 3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section "Hangers and Supports for Plumbing Piping" for insulation shields.
 - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 - 5. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints.
 - 6. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints.
 - 7. For cold pipes, apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.
- I. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves (except balancing and flow control valves), strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Butt tightly against adjoining pieces and bond with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves (except balancing and flow control valves), flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- J. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- K. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
- L. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

3.06 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing Plumbing insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.07 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.08 PIPING SYSTEM INSULATION SCHEDULE

- A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.
- B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.
- C. Omit insulation on the following:
 1. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.
 2. Chrome-plated exposed piping
 3. Water Hammer Arrestors
 4. Balancing and flow valves
 5. Buried piping

6. Pre-insulated equipment.
7. Cold water piping
8. Condensate piping
- D. Cold Piping (minimum operating temperature less than 60 degrees F.)
 1. Service
 - a. Potable cold water piping.
 - b. Horizontal interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
 - c. Horizontal and vertical interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
 - d. Horizontal and vertical interior above-ground overflow storm drainage piping and vertical run from roof drain to horizontal run. Where vertical overflow storm drainage piping from the outlet exceeds 15 feet, only insulate within 15 feet of the outlet.
 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Mineral fiber.
 - b. Flexible elastomeric.
- E. Hot Temperature Piping (105 degrees to 180 degrees F (40 to 82 degrees C)):
 1. Service:
 - a. Hot water supply and return piping.
 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Mineral fiber.
 - b. Flexible elastomeric.

3.09 PIPE INSULATION THICKNESS SCHEDULE

- A. Piping Inside Masonry Wall Units:
 1. Insulate cold, hot, and hot water recirculation piping installed inside of masonry walls where the piping needs to be insulated as the wall is constructed as described below:
 - a. Flexible Elastomeric: 1/2" thick for pipe sizes up to and including 2", 1" thick for pipe sizes 2-1/2" to 6" (largest size permitted).
- B. IECC – 2021 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness			Nominal Pipe or Tube Size (in.)					
	Insulation Conductivity		Mean Rating Temp., °F.						
	Conductivity, Btu·in./(hr·ft²·°F)								
			<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8		
			Insulation Thickness, in.						
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0		
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5		
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0		

Notes:

1. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
2. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} - 1]$ where
 - a. T = minimum insulation thickness (in.),
 - b. r = actual outside radius of pipe (in.),

- c. t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
 - d. K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and
 - e. k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- 3. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
 - 4. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.10 PIPING JACKET SCHEDULE

- A. Exposed piping within mechanical rooms (above 10 feet):
 - 1. Semi-rigid PVC.
 - 2. Rigid aluminum shell.
- B. Exposed piping:
 - 1. All-service jacket.
 - 2. Semi-rigid PVC.
- C. Piping within return air plenums:
 - 1. All-service jacket.

END OF SECTION 22 0700

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SECTION 22 1100
WATER DISTRIBUTION PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties within the building to a point 5 feet outside the building.
- B. Contractors Option:
 - 1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves, and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined water distribution piping systems where used shall be provided in compliance with specification Section 221111 "Mechanically Joined Plumbing Piping Systems".
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 2. Division 22 Section "Identification for Plumbing Piping and Equipment" for labeling and identification of water distribution piping.
 - 3. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.
 - 4. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, dielectric unions, dielectric flanges, and mechanical sleeve seals.
 - 5. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.
 - 6. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials, and methods for hanging and supporting water distribution piping.
 - 7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.
 - 8. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties," for material and methods for trap primer outlet piping.

1.02 DEFINITIONS

- A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.
- B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.
- C. Pipe sizes used in this Specification are nominal pipe size (NPS).
- D. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specifications Sections.

1. Product data for each piping specialty and valve specified.
2. Welder Certificates signed by Contractor certifying that welders comply with requirements specified in Article "Quality Assurance" below.
3. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
4. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."
5. Test reports specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- B. Regulatory Requirements: Comply with the provisions of the following codes:
 1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.
- C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.
- D. Pipe, fittings, and specialties shall be manufactured in the United States or be certified to meet ASTM and ANSI standards.

1.05 SPARE PARTS

- A. Maintenance Stock: Furnish one valve key for each key-operated wall hydrant, hose bibb, fixture supply, or faucet installed.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Plumbing Pipe Support Brackets
 - a. Holdrite
 - b. PROFLO
 - c. Sioux Chief
 2. Roof Hydrants
 - a. Jay R. Smith Mtg Co.
 - b. Mifab Manufacturing, Inc.
 - c. Prier, Inc.
 - d. Woodford Mfg. Co.
 - e. Zurn Industries
 3. Sanitary Roof Hydrants
 - a. Hoeptner Perfected Products
 - b. Jay R. Smith Mtg Co.
 - c. Prier, Inc.

- d. Mapa
- e. Woodford Mfg. Co.

2.02 PIPE AND TUBE MATERIALS, GENERAL

- A. Pipe and Tube: Refer to Part 3, Articles "Above Ground Water Distribution Pipe and Fittings" or "Below Ground Water Distribution Pipe and Fittings", for identification of systems where the materials listed below are used.
- B. Copper Tube: ASTM B88, Type L Water Tube, drawn temper.
- C. Steel Pipe: ASTM A53, Type E or S, schedule 40, Grade B, galvanized, threaded ends.
- D. Brass Pipe: Chrome Plated Schedule 40 ASTM B43 iron pipe size (IPS.)

2.03 FITTINGS

- A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.
- B. Galvanized Malleable Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ASME B1.20.1.
- C. Ductile or Gray-Iron Flanged Fittings: AWWA C110 Class 125 with AWWA C116 epoxy coating inside and outside.
- D. Brass Fittings: Chrome plated ANSI B16, Class 125 with threaded connections.
- E. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125, raised ground face, bolt holes spot faced.
- F. Bronze Flanges: ANSI B16.24, Class 150, raised ground face, bolt holes spot faced.

2.04 JOINING MATERIALS

- A. Solder Filler Metal: ASTM B32 Alloy Sb-5, 95-5 Tin-Antimony.
- B. Brazing Filler Metals: AWS A5.8, Bag-7 Silver.
- C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and design temperatures and pressures.

2.05 PIPING SPECIALTIES

- A. Pipe Support Brackets:
 - 1. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of 1/2" on 2" centers and holes of 3/4" or 1" on 4" centers.
 - 2. Pipe Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent pipe in wall.
 - 3. Carrier Bracket: 20 gauge copper bracket with 1" hole for supporting rough-in for flush valve copper tube and bolt slot for attaching to chair carrier.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install piping, valves and specialties in accordance with manufacturer's installation instructions.

3.02 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS

- A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 8 inches and smaller, within the building.

3.03 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

- B. Use fittings for all changes in direction and branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.
- I. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- J. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves packing, and sealant. Refer to Division 22 Section "Basic Piping Materials and Methods" for additional information.
- K. Install piping with 1/32-inch-per-foot (1/4 percent) downward slope towards drain point.
 - a. Install piping level with no pitch.

3.04 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Pipe Attachments: Install the following:
 - 1. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs. Provide copper coated riser clamps when in contact with copper tube.
 - 3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Supports and Anchors" and "Plumbing Insulation".
 - 4. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls and for securing 1-1/4" to 2" copper tube inside walls and chases for battery fixtures. Secure clamp to the copper tube.
 - a. Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section "Plumbing Insulation" for requirement for maintenance of the vapor barrier and vapor barrier seal method.
 - 5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of stainless steel tube 2" and smaller on walls or for securing tube inside walls for connection to faucets.
 - 6. Support copper tube in chases and walls at plumbing fixtures with plastic or copper brackets secured to structure and U-bolts sized to bare on the pipe.
 - 7. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube. Provide two piece straps and

360° insulation protection shields sized for the insulation thickness used for the pipe for all insulated pipes.

8. Secure copper tube rough-in for individual fixtures with sheet stud brackets attached to the wall studs or pipe mounting brackets attached to the fixture waste & vent pipe at each plumbing fixture.
 9. Secure 1" and smaller copper water tubing in stud walls at stud penetrations with tube suspension clamps.
 - a. Cut hole through non-supporting studs with a minimum 1/8" clearance around each uninsulated copper tube or insulated copper tube.
 - b. Seal each joint of insulation and tube suspension clamp to maintain the insulation barrier. Refer to Division 22 "Plumbing Insulation" for requirement for maintenance of the vapor barrier similar to insulation butted against insulation inserts and vapor barrier seal method.
 10. Provide roll hangers for individual horizontal runs 100 feet or longer.
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 4	12	10	3/8
5	12	10	1/2
6	12	10	1/2
8	12	10	1/2

- D. Support water piping within 12" of each elbow or tee and for water piping 2-1/2" and larger at each valve or strainer.
- E. Support water piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

3.05 PIPE AND TUBE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
 1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.
 2. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
 3. Heat joints to proper and uniform temperature.
- C. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:
 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

- a. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- D. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- E. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Provide dielectric waterway fittings for 2" and smaller in concealed locations. Dielectric unions, waterway fittings and flanges are specified in Section "Basic Piping Materials and Methods".
- F. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

3.06 FIELD QUALITY CONTROL

- A. Inspections: Inspect water distribution piping as follows:
 - 1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
 - 2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
 - d. Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.
- B. Piping System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 - 1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 - 2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
 - 3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
 - 5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.07 ADJUSTING AND CLEANING

- A. Clean and disinfect water distribution piping as follows:
1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.
 2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not proscribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:
 - a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
 - b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.
 - c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
 - d. Following the allowed standing time, flush the system with clean, potable water until chlorine residual is lowered to incoming city water level.
 - e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.
 3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

END OF SECTION 22 1100

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SECTION 22 1300
SANITARY DRAINAGE AND VENT PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 3. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.
 - 4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
 - 5. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
 - 6. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.
 - 7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

1.02 DEFINITIONS

- A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer.
- B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for the following products:
 - 1. Drainage piping
 - 2. Drainage piping specialties
 - 3. No-hub fitting restraints
- C. Test reports specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following codes:
1. 2018__ International Plumbing Code

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Drainage Piping Specialties, including backwater valves, expansion joints, cleanouts, floor drains, cast-iron trench drains and vandal-proof vent caps:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Mfg. Co.
 - c. Mifab Manufacturing Co.
 - d. Sioux Chief Manufacturing Co. Inc.
 - e. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - f. Watts Industries, Inc.
 - g. Zurn Industries, Inc.; Hydromechanics Div.
 2. Heavy Duty Hubless Couplings
 - a. Anaco Husky HD-2000
 - b. Clamp-All 80in. lb.
 - c. Ideal Tridon "HD"
 - d. Mifab Manufacturing, Inc. #MI-XHUB-series
 - e. Mission Rubber Company, "Heavy Weight"
 - f. ProFlo "HD"
 3. Shielded Transition Couplings
 - a. FERNCO, "Proflex 3000 Series"
 - b. Anaco-Husky #SD-4200
 - c. Mission Rubber Company, "Band Seal Specialty Couplings"
 4. Hubless Couplings:
 - a. Anaco
 - b. Ideal Tridon
 - c. Mifab Manufacturing, Inc. #MI-HUB- series
 - d. Mission Rubber Company
 - e. ProFlo "PFNH"
 - f. Tyler Pipe / Soil Pipe Division
 5. No-Hub Fitting Restraints
 - a. Holdrite
 6. PVC DWV Expansion Joints
 - a. Charlotte Pipe and Foundry Company #133
 - b. Spears Manufacturing Company #S119

2.02 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

- A. Refer to Part 3, Article "Pipe Applications - Above Ground, Within Building" for identification of systems where the materials listed below are used.
- B. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, no-hub pipe and fittings and bearing the trademark of CISPI and NSF.
 - 1. Couplings and compression gaskets, NSF certified: ASTM C564 and CISPI 310.
 - 2. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.
- C. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.
 - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- D. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.
 - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- E. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
 - 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
 - 2. Solvent: ASTM D2564.
- F. PVC Pressure Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 with "solid wall" PVC meeting ASTM D1784 with cell class 12454.
 - 1. Solvent: ASTM D2564.
 - 2. Fittings: Schedule 40 meeting ASTM D2466 with solvent cement socket joints.
- G. Steel Pipe: ASTM A53, Type E or S, schedule 40, Grade B, galvanized, threaded ends.
 - 1. Galvanized Malleable Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ASME B1.20.1.
- H. "Flowguard Gold" CPVC Water Distribution Tube (1/2" to 2"): ASTM D2846, Copper Tube Size (CTS), pipe with a cell class of 24448 as identified in ASTM 1784. NSF 14 certified and NSF 61 listed. Meeting ASTM E84 for 25 / 50 flame / smoke rating.
 - 1. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.
- I. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.03 PVC DWV EXPANSION JOINTS

- A. Schedule 40 PVC DWV meeting ASTM D2665 with socket connections and telescoping expansion joint with EPDM O-ring seal.

2.04 NO-HUB FITTING RESTRAINTS

- A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.02 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

- A. Install hubless, cast-iron soil pipe and fittings for 15" and smaller soil, waste, and vent pipe.

- B. Install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings, copper sweat X screwed with solder joints, for waste connections from urinals, lavatories, sinks, water coolers, and kitchen equipment to cast iron drainage piping.
- C. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller, with 3/4" minimum size and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4" and larger for waste connections from kitchen equipment and terminate over floor receptors with air gap.
- D. .

3.03 PIPE AND TUBE JOINT CONSTRUCTION

- A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."
- B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:
 - 1. Install hubless couplings complying with CISPI 310 on soil, waste and vent piping.
 - 2. Install hubless couplings complying with CISPI 310 on and soil and waste piping 3" and smaller and all vent piping.
 - 3. Install heavy duty hubless couplings on soil or waste stacks, soil and waste piping connections to soil or waste stacks and all soil and waste piping 4" and larger.
 - 4. Install No-Hub fitting restraints on joints 5" and larger at:
 - a. Changes of direction from vertical to horizontal
 - b. 4" branch connections, including tees, wyes and wye combination fittings to soil and waste piping 5" and larger
 - c. Horizontal changes of direction 22-1/2 degrees and greater
 - d. Changes in diameter of two pipe sizes or greater.
- C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.
- D. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.
- E. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.

3.04 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Paint exposed copper drain lines serving kitchen equipment with a minimum of two coats of chromium-based paint.

- H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section "Basic Piping Material and Methods" for special sealers and materials.
- I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Basic Piping Material and Methods" for special sealers and materials.
- J. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.
- K. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger. [Install all drainage piping upstream of grease interceptors at a minimum slope of 1/4 inch per foot.] Install vent piping pitched to drain back by gravity to the sanitary drainage piping system.

3.05 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".
 - a. Install high density insulation on insulated pipe.
 - 3. Provide vinyl coated hangers and riser clamps for use with PVC pipe and CPVC CTS tube.
 - 1. Provide roll hangers for individual horizontal runs 100 feet or longer.
 - 2. Provide ceiling flanges attached to the floor, all thread rod and split ring pipe clamps for indirect drains and condensate drains supported from the floor 2" and smaller.
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size – In.	Steel Pipe Max. Span – Ft.	Copper Tube Max. Span – Ft.	Min. Rod Dia. - In.
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 4	12	10	3/8
5	12	10	1/2
6	12	10	1/2
8	12	10	1/2
10 to 12	12	10	5/8
14 to 15	12	N/A	3/4

Nom. Pipe Size <u>In Inches.</u>	CTS CPVC Tube <u>Max. Span - Ft.</u>	CPVC Tube Min. Rod <u>Dia. - In.</u>
1/2	3	3/8
3/4	3	3/8
1	3	3/8
1-1/4	4	3/8
1-1/2	4	3/8
2	4	3/8

1. Support all sizes of horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide support at each horizontal branch.
 2. Support all sizes of horizontal of PVC piping every four feet.
 3. Support piping within 12" of each elbow or tee.
- D. Sway bracing:
1. Provide rigid sway bracing for pipe 4" and larger at changes of direction greater than 45 degrees.
 2. Secure horizontal base of stack to structure with riser clamp within at the fitting changing direction of flow from vertical to horizontal. Provide rods of size equal to cast iron pipe size scheduled above in pipe hanger schedule.

3.06 CONNECTIONS

- A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.07 FIELD QUALITY CONTROL

- A. Inspections
 1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
 2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.
 - d. Reports: Prepare inspection reports, signed by the plumbing official.
- B. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1" water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.
5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.08 ADJUSTING AND CLEANING

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.09 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 22 1300

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SECTION 22 0000
DIVISION 22 TABLE OF CONTENTS

220010	*GENERAL PLUMBING REQUIREMENTS
220500	*COMMON WORK RESULTS FOR PLUMBING
220515	*BASIC PIPING MATERIALS AND METHODS
220529	*HANGERS AND SUPPORTS FOR PLUMBING PIPING
220553	*IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT
220700	PLUMBING INSULATION
221100	WATER DISTRIBUTION PIPING & SPECIALTIES
221300	SANITARY DRAINAGE & VENT PIPING & SPECIALTIES

END OF SECTION 22 0000

*** PROVIDE FOR EVERY PROJECT**

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SECTION 22 0010
GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 22 of the Specifications and Drawings numbered with prefixes, Mor ME generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.02 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.03 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code – 2021____
IMC	International Mechanical Code – 2021____
IPC	International Plumbing Code – 2021____
IECC	International Energy Conservation Code – 2018____
ADA	American Disabilities Act
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Airc Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.04 DEFINITIONS

A. General:

1. **Furnish:** When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
2. **Install:** The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. **Provide:** The term "provide" means "to furnish and install, complete and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. 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.
 - b. 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.
9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.05 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The Contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The Contractor shall inform the Architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The Contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.
- D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

- E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.06 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of 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 trade.
 - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
 - 4. Indicate required installation sequence to minimize conflicts between entities.
 - 5. 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 Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 - 6. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

1.08 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the

Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.
- M. Provide welders' qualification certificates.

1.09 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check

made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
 - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 - 2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
 - 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 - 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain data listed in Table 5.
- F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 2 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.
- B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or

damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

- D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

1.15 GUARANTEES AND WARRANTIES

- A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
- C. The following additional items shall be guaranteed:
1. Piping shall be free from obstructions, holes or breaks of any nature.
 2. Insulation shall be effective.
 3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.16 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings:
1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting their bid to determine the nature and extent of work involved.
 2. Work in the existing building shall be scheduled with the Owner.
 3. Certain demolition work must be performed prior to the remodeling. The Plumbing Contractor shall perform the demolition which involves Plumbing and Plumbing systems, fixtures, equipment, piping, equipment supports or foundations and materials.
 4. Plumbing Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Plumbing Contractor during this demolition shall become their property and shall be removed by the Plumbing Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
 5. Plumbing Contractor shall relocate and reconnect Plumbing facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Plumbing equipment or materials are removed, the Plumbing Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
 6. General Contractor shall install finish material.
 7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
 8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

9. Locate, identify, and protect Plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

PART 3 - EXECUTION

3.01 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.02 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned Plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing Plumbing materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- E. Plumbing Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 1. Inactive and obsolete piping, fittings and specialties, equipment, controls, fixtures and insulation.
 - a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 22.
- F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.03 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.
- G. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.04 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.05 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 - 1. Submit complete Operation and Maintenance Manuals.
 - 2. Submit complete Record Drawings.
 - 3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 22 that contain special inspection requirements.
 - 4. Start-up testing of systems.
 - 5. Removal of temporary facilities from the site.
 - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, The Contractor shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 22 0010

TABLE 1: PLUMBING SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

<u>SPECIFICATION NUMBER/TITLE</u>		<u>CODE DESIGNATION</u>
220010	General Plumbing Requirements	NONE
220500	Common Work Results For Plumbing	A, B, G, M
220515	Basic Piping Materials And Methods	B, G
220523	General-Duty Valves For Plumbing Piping	B
220529	Hangers And Supports For Plumbing Piping	B, F, G, H
220553	Identification For Plumbing Piping & Equipment	B, L, M
220700	Plumbing Insulation	B, M
221100	Water Distribution Piping & Specialties	B, G, H
221300	Sanitary Drainage & Vent Piping & Specialties	B

CODED LEGEND

A	Shop Drawings
B	Product Data and equipment weights
C	Performance Data, Curves, Certificates and Test Data
D	Coordination Drawings
E	Wiring Diagrams and short circuit current ratings
F	Installation Instructions
G	Welder's Certificates
H	Certificates
I	Calculations
J	Special Inspections
K	Special Warranties
L	Material Samples
M	Schedules
N	Recommended Spare Parts List

TABLE 2: SPARE PARTS REQUIREMENTS FOR PLUMBING EQUIPMENT

<u>SECTION NUMBER</u>		<u>RECEIVED/DATE/INITIAL</u>
220553	Identification For Plumbing Piping & Equipment	_____
221100	Water Distribution Piping & Specialties	_____

Owner's Signature

TABLE 5: PLUMBING SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

<u>SPECIFICATION NUMBER/TITLE</u>		<u>CODE DESIGNATION</u>
220500	Common Work Results For Plumbing	B
220515	Basic Piping Materials And Methods	B
220523	General-Duty Valves For Plumbing Piping	B, H, I
220529	Hangers And Supports For Plumbing Piping	B
220553	Identification For Plumbing Piping & Equipment	B
220700	Plumbing Insulation	B
221100	Water Distribution Piping & Specialties	A, B, F, H, I
221300	Sanitary Drainage & Vent Piping & Specialties	A, B, F

CODED LEGEND

A	As-Built Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Wiring Diagrams
E	Operating Instructions
F	Test Reports
G	Warranties
H	Recommended Spare Parts List
I	Service and Maintenance Instructions

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples
☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

Similar Installation: _____

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No	
Additional Comments:	☐ Attached	☐ None	

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

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SECTION 22 0500
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:
 - 1. Access panels and doors in walls, ceilings, and floors for access to Plumbing materials and equipment.
 - 2. Sleeves for Plumbing penetrations.
 - 3. Miscellaneous metals for support of Plumbing materials and equipment.
 - 4. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.
 - 5. Joint sealers for sealing around Plumbing materials and equipment.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 22 Section "Basic Piping Materials and Methods" for materials and methods for mechanical sleeve seals.
 - 3. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for indirect drain piping and installation requirements.
 - 4. Division 26 Section "Common Work Results for Electrical" required electrical devices.
 - 5. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.02 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 22 Section "General Plumbing Requirements".
 - 1. Product data for the following products:
 - a. Access panels and doors.
 - b. Through and membrane-penetration firestopping systems.
 - c. Joint sealers.
 - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.
 - 3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
 - 4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."
 - 5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit

illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.
- C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.04 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

<u>Space</u>	<u>RC Levels</u>
Broadcast Studio	25

1.05 ACCESS TO EQUIPMENT

- A. Manufacturer:
 - 1. Bar-Co., Inc.
 - 2. Elmdor Stoneman.
 - 3. JL Industries
 - 4. Jay R. Smith Mfg. Co.
 - 5. Karp Associates, Inc.
 - 6. Milcor
 - 7. Nystrom Building Products
 - 8. Wade
 - 9. Zurn
- B. Access Doors:
 - 1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Plumbing Piping" for labeling of access doors.
 - 2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
 - 3. Access doors must be of the proper construction for type of construction where installed.
 - 4. The exact location of all access doors shall be verified with the Architect prior to installation.

5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
8. Locking Devices: Flush, screwdriver-operated cam locks.
9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

1.06 GROUT

- A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.
- B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.
- C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

1.07 PENETRATIONS

- A. Sleeves:
 1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
- B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.
- C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

1.08 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.

- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

1.09 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPB rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

1.10 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
 - a. "Dow Corning 790," Dow Corning Corp.
 - b. "Silglaze II SCS 2801," General Electric Co.
 - c. "Silpruf SCS 2000," General Electric Co.
 - d. "864," Pecora Corp.
 - e. "Rhodia 5C," Rhone-Poulenc, Inc.
 - f. "Spectrem 1," Tremco, Inc.
 - g. "Spectrem 2," Tremco, Inc.
 - h. "Dow Corning 795," Dow Corning Corp.
 - i. "Rhodia 7B," Rhone-Poulenc, Inc.
 - j. "Rhodia 7S," Rhone-Poulenc, Inc.
 - k. "Omniseal," Sonneborn Building Products Div.
 - 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
 - a. "Dow Corning 786," Dow Corning Corp.
 - b. "Sanitary 1700," General Electric Co.
 - c. "898 Silicone Sanitary Sealant," Pecora Corp.
- D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600," Bostik Construction Products Div.
 - b. "AC-20," Pecora Corp.
 - c. "Sonolac," Sonneborn Building Products Div.
 - d. "Tremflex 834," Tremco, Inc.

1.11 ACOUSTICAL SEALANTS

- A. General: Penetrations by pipes through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
- B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.
- C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
- D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m³).

1.12 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:
 - 1. 3M Corp., Fire Barrier Sealant
 - 2. Hilti
 - 3. Owens Corning, Firestopping Insulation.
 - 4. Pecora, AC-20 FTR
 - 5. RectorSeal
 - 6. Specified Technologies Inc.,
 - 7. United States Gypsum Company SHEETROCK Firecode Compound
 - 8. Tremco, Tremstop Fyre-Sil.

PART 2 - EXECUTION

2.01 INSTALLATION, GENERAL

- A. Install access doors and sealants in accordance with manufacturer's installation instructions.

2.02 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

2.03 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

2.04 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

2.05 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

2.06 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

2.07 PENETRATIONS:

- A. Construction in Existing Facilities:
 - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
- B. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.
- C. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.
- D. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.
- E. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- I. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.
- J. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section "Basic Piping Materials and Methods".

2.08 ACOUSTICAL PENETRATIONS

- A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the plumbing equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.
- B. Domestic Water, Sewer, Drain and Vent Piping
 - 1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the

piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION 22 0500

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SECTION 22 0515
BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Common Work Results for Plumbing" for materials and methods for sleeve materials.

1.02 DEFINITIONS

- A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.03 SUBMITTALS

- A. Refer to Division 01 and Division 22 Section "General Plumbing Requirements" for administrative and procedural requirements for submittals.
- B. Product Data: Submit product data on the following items:
 - 1. Dielectric Unions
- C. Quality Control Submittals:
 - 1. Submit welders' certificates specified in Quality Assurance below.
- D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.
- E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.
- F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.04 QUALITY ASSURANCE

- A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.
- C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.
- D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:
 - 1. Pipe Escutcheons:
 - a. AWI Manufacturing.
 - b. Keeney Manufacturing Company
 - c. Wal-Rich Corp.
 - d. Jones Stephens Corp.
 - 2. Dielectric Unions:
 - a. JOMAR International
 - b. Smith Cooper International
 - c. Watts Regulator Co.
 - d. Zurn Industries

2.02 PIPE AND FITTINGS

- A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

- A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.
- B. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
- D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

2.04 PIPING SPECIALTIES

- A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated and of depth adequate to conceal protruding piping. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
- B. Unions:
 - 1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
 - 2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.
- C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

- D. Sleeves:
 - 1. Sleeve: Refer to Division 22 Section "Common Work Results for Plumbing" for sleeve materials.
- E. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.

3.02 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.03 INSTALLATIONS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
- C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- I. Verify final equipment locations for roughing in.

3.04 PIPING PROTECTION

- A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.05 PENETRATIONS

- A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

- B. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe , using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - 1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
- C. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.
- D. Acoustical Barrier Penetrations: Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. The internal diameter of the sleeve shall be a minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.
 - 1. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.06 FITTINGS AND SPECIALTIES

- A. Use fittings for all changes in direction and all branch connections.
- B. Remake leaking joints using new materials.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install dielectric unions for piping 2" and smaller to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.
- E. Install dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.

3.07 JOINTS

- A. Steel Pipe Joints:
 - 1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
 - 2. Pipe Larger Than 2":
 - a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
 - b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
 - c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

- B. Non-ferrous Pipe Joints:
 - 1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.
 - 2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
- C. Joints for other piping materials are specified within the respective piping system Sections.

3.08 PIPE FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.
- B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

END OF SECTION 22 0515

PLUMBING & PLUMBING PIPING SYSTEMS
INSPECTION REPORT FORM

Project Name: _____
Project No: _____ Contractor Project No. _____
General Contractor: _____
Inspection Date: _____ Temperature: _____

System Inspected

Building: _____
Location/Description: _____
Service: _____

Inspection Results

Time of Inspection: _____
Approval to Insulate: Y N Approval to Cover in Wall: Y N
Approval to backfill Y N

Signatures

Witness: _____ Representing: _____
Witness: _____ Representing: _____
Witness: _____ Representing: _____

Remarks

Contractor Supervisor's signature: _____

SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components.
- B. Horizontal-piping hangers and supports.
- C. Shields
- D. Anchors and fasteners.
- E. Miscellaneous materials.
- F. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Plumbing Insulation", for high density insulation for protecting insulation vapor barrier and materials and methods for piping hanger installations.
 - 2. Division 22 "Water Distribution Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical domestic water distribution and heat traced piping of sizes and materials indicated.
 - 3. Division 22 "Sanitary Drainage & Vent Piping and Specialties", for pipe hanger types and spacing for heat traced and cold sanitary piping of sizes and materials indicated.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 2. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 3. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.03 SUBMITTALS

- A. Product Data : Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.
- B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.
- C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 22 Section "General Plumbing Requirements".
- E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.

1. Application of protective inserts, and shields at pipe hangers for each type of insulation and hanger.
- F. Installer's Qualifications: Include evidence of compliance with specified requirements.
- G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Field-Welding:
 1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
 3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."
- D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.06 DEFINITIONS

- A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS AND MATERIALS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 1. Comply with MSS SP-58.
 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.

- b. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
 - e. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.
- B. Metal Channel (Strut) Framing Systems:
 - 1. Manufacturers:
 - a. Cooper B-Line.
 - b. Ferguson Enterprises/FNW.
 - c. PHD Manufacturing.
 - d. Thomas & Betts Corporation.
 - e. Unistrut, a brand of Atkore International Inc.
 - f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.
 - 4. Channel Material:
 - a. Indoor Dry Locations: Galvanized steel or zinc-plated steel.
 - b. All nuts, brackets, and clamps shall have the same finish as the channel.
 - 5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.
 - 6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.
 - 7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.
- C. Hanger Rods:
 - 1. Material:
 - a. Indoor Dry Locations: Zinc-plated steel.
 - 2. Threaded both ends or continuously threaded.
 - 3. Minimum Size: Reference piping specification sections for rod thicknesses.
 - 4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.02 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. MANUFACTURERS
 - 1. ASC Engineered Solutions.
 - 2. Cooper B-Line, Inc.
 - 3. Elite Components
 - 4. ERICO/Michigan Hanger Co./Caddy
 - 5. Ferguson/FNW.

6. Halfen-DEHA.
 7. Hilti.
 8. National Pipe Hanger Corporation.
 9. PHD Manufacturing.
 10. Power-Strut.
 11. Unistrut.
- B. Single Hangers:
1. Split Ring: Carbon steel, adjustable swivel, split ring type.
 2. Split Ring 2 inch and smaller: Copper alloy, split ring type.
 3. Clevis Hanger: Carbon steel, adjustable, clevis type.
 4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.
- C. Trapeze and Strut-mounted Supports:
1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
 2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.
- D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:
1. Manufacturers:
 - a. ASC Engineered Solutions.
 - b. Holdrite.
 - c. Klo-Shure.
 2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.
- E. Spring Hangers:
1. Reference Section "Vibration Isolation for Plumbing Piping and Equipment" for spring isolation hangers.
- F. Wall Supports:
1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.
 2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.
- G. Pre-Insulated Supports:
1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. ASC Engineered Solutions
 - c. Armacell.
 - d. Buckaroos, Inc.
 - e. Cooper B-Line, Inc.
 - f. Pipe Shields, Inc.

2. General Construction and Requirements:
 - a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.
 - b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Waterproof calcium silicate insulation shall conform to ASTM C795.
 - d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.
 - e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.
3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.03 SHIELDS

A. Insulation Protection Shield:

1. Sheet metal construction, meeting SP-58 Type 40, of 18 gauge for 5-1/2" inside dimension and smaller, 16 gauge for 6-1/2" to 10-3/4" inside dimension 14 gauge for 11-3/4" to 17" inside dimension, and 12 gauge for 18" to 28" inside dimension.
2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
4. For pipes 2 inch and smaller using fiberglass or flexible elastomeric insulation without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in)					
		Hanger Spacing, (ft)					
		5	6	7	8	9	10
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
≤ 2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

- B. 360° Insulation Protection Shield: Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Plastic Shields:
 1. Manufacturers:
 - a. Armacell.
 - b. Eaton.
 - c. Hydra-Zorb.
 - d. PHD Manufacturing.
 - e. Zsi Foster.
 2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.04 ANCHORS AND FASTENERS

- A. Manufacturers:
 - 1. Hilti, Inc.
 - 2. Illinois Tool Works, Inc.
 - 3. Phillips.
 - 4. Powers Fasteners, Inc.
 - 5. Rawl.
 - 6. Simpson Strong-Tie Company Inc.
- B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 1. Concrete: Use preset concrete inserts or expansion anchors.
 - 2. Solid or Grout-Filled Masonry: Use expansion anchors.
 - 3. Hollow Masonry: Use toggle bolts.
 - 4. Hollow Stud Walls: Use toggle bolts.
 - 5. Steel: Use beam clamps.
 - 6. Sheet Metal: Use sheet metal screws.
 - 7. Wood: Use wood screws.
 - 8. Plastic and lead anchors are not permitted.
 - 9. Hammer-driven anchors and fasteners are permitted only as follows:
 - a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
 - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.
- D. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - 1. Comply with MFMA-4.
 - 2. Channel Material: Use galvanized steel.
 - 3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
 - 4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rod dimensions.
 - 5. Manufacturers:
 - a. Same as manufacturer of metal channel (strut) framing system.
 - b. DeWalt "Bang-It" concrete inserts.
- E. Post-Installed Concrete and Masonry Expansion Anchors:
 - 1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 - 2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.
- F. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.
 - 1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 - 2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

- G. Vibration Isolation Anchors: Reference Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for vibration isolation anchors.

2.05 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Malleable Iron: ASTM A47
- H. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION, GENERAL

- A. Install hangers and supports in accordance with manufacturer's installation instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

3.03 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.
- B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- C. Space attachments within maximum piping span length specified in Division 22 piping sections.
- D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- E. Install hangers, supports, clamps and attachments to support piping properly from building structure.
- F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.
- G. Hanger and clamps sizing:
 - 1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
 - 2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.
 - 3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.

4. Refer to Division 22 Section "Plumbing Insulation" for definition of hot and cold piping and required insulation thickness.
- H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 22 piping sections.
 1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
 2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
 - a. Uninsulated Copper Pipe: Install with plastic galvanic isolators
 - b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".
- I. Install building attachments within concrete or to structural steel.
 1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 22 piping sections.
 2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.
- K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
 1. Riser Clamps: Attach riser clamps to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section "Plumbing Insulation".
 - a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert for cold piping 2-1/2 inches and larger.
 2. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section "Plumbing Insulation". Do not use polymer-based shields for hot piping.
 - a. Exception for horizontal cold-piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.
 3. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.
 4. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
- O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide

channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".

P. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.

3.04 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.05 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.06 FIELD QUALITY CONTROL

- A. Examine support and attachment components for damage and defects.
- B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."
 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.
- F. Correct deficiencies and replace damaged or defective support and attachment components.

3.07 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

- B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:
- C. Single Hangers:
 - 1. All pipe sizes 1-1/2 inch and less:
 - a. Band hanger.
 - b. Swivel split ring.
 - c. Clevis hanger.
 - 2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.
 - 3. Cold and Hot pipe sizes 6 inches and greater: Roll support hanger.
 - 4. All drainage pipe sizes: Clevis hanger.
- D. Trapezes and Strut-mounted Supports:
 - 1. All pipe sizes less than 6 inches: Two-piece clamp.
 - 2. Pipe sizes 6 inches and greater: Roll support.
- E. Wall Supports:
 - 1. Pipe sizes 3 inches and less:
 - a. Two-hole strap mounted to wall.
 - b. Welded steel bracket with reinforced angle or strut.
 - 2. Pipe sizes 4 inch and greater:
 - c. U-bolt
 - d. Welded steel bracket with reinforced angle or strut.

END OF SECTION 22 0529

SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.
- B. Types of identification devices specified in this Section include the following:
 - 1. Plastic Pipe Markers
 - 2. Plastic Tape

1.02 CODES AND STANDARDS:

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
- D. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section "General Plumbing Requirements."

1.04 SPARE PARTS

- A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 - 1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:
 - 1. Advanced Graphic Engraving, LLC.
 - 2. Brady Co.
 - 3. Brimar Industries, Inc.
 - 4. Craftmark.
 - 5. Kolbi Pipe Marker Co.
 - 6. Seton

2.02 PLUMBING IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.03 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1
- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - 2. Adhesive lap joint in pipe marker overlap.
 - 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".
- E. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
 - 1. Laminated or bonded application of pipe marker to pipe (or insulation).
 - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 - 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
- G. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
- H. Lettering: Comply with piping system nomenclature as specified, scheduled, or shown, and abbreviate only as necessary for each application length.

2.04 PLASTIC TAPE

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - 1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
- B. Application: Provide piping system identification for the following systems:
 - 1. Domestic cold water piping.
 - 2. Domestic hot water piping.
 - 3. Domestic hot water recirculating piping.
 - 4. Sanitary and waste piping.
 - 5. Storm water piping.
 - 6. Vent piping.
- C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
 - 1. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.
 - 2. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.
 - 3. At access doors, manholes and similar access points which permit view of concealed piping.
 - 4. Within 5 feet of major equipment items and other points of origination and termination.
 - 5. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

END OF SECTION 22 0553

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SECTION 22 0700
PLUMBING INSULATION

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

- A. Piping Insulation.

1.02 RELATED REQUIREMENTS

- A. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields and high-density insulation inserts.

1.03 DEFINITIONS

- A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.
- B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.
- C. Exposed: Insulation that is visible from the occupied space.
- D. NAIMA: North American Insulation Manufacturers Association

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of Plumbing insulation.
- B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of Plumbing insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Flame/Smoke Ratings: Provide composite plumbing insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.01 PIPING INSULATION MATERIALS

- A. Mineral Fiber (rock, slag, or glass):
 - 1. Manufacturers:
 - a. Knauf Insulation
 - b. Johns Manville
 - c. Owens Corning
 - 2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.
 - a. K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.
 - b. Minimum Service Temperature: 0 degrees F
 - c. Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.
 - d. Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.
 - 3. Factory Applied Jacket: ASTM C1136, Type I.
 - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.
 - b. Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.
 - c. Color: White.
- B. Flexible Elastomeric:
 - 1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.
 - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 297 degrees F
 - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
 - 3. Factory Applied Jacket:
 - a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Jacket requirements in Part 3 of this specification for application of this jacket.
- C. Field-Applied Jacket:
 - 1. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
 - a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
 - b. Manufacturers:
 - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
 - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
 - 3) Or approved equal.

2. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in)		
	Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco

- a. Banding:
 - 1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
 - 2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.
3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
- D. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
 1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
 2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.
 3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
 4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02

Notes:

5. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
6. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.
- F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

- H. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW.
 - 1. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - 2. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
- I. Pipe Insulation Accessories: Provide staples, Bands, Wires, and Cement and other appurtenances as recommended by insulation manufacturer for applications indicated.
- J. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- K. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 PROTECTION AND REPLACEMENT

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.
- B. Repair existing plumbing insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.
- C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.03 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

3.04 PLUMBING PIPING SYSTEM INSULATION

- A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Exposed Piping: Locate insulation and cover seams in least visible locations.
- E. Cold Piping Insulation:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Provide with factory applied vapor barrier jacket.
 - 3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers and

Supports for Plumbing Piping” for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 5. Secure all-service jacket with self-sealing longitudinal laps.
- F. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture infiltration.
- G. Hot Piping Insulation:
1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
 2. Provide jackets without vapor barrier. Jackets with factory applied vapor barrier are allowed.
 3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers and Supports for Plumbing Piping” for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 5. Secure all-service jacket with self-sealing longitudinal laps.
 6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

3.05 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.
- C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- E. Clean and dry pipe surfaces prior to insulating.
- F. Cold Pipe Insulation:
1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
 2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section “Hangers and Supports for Plumbing Piping” for pre-insulated supports.
 3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section “Hangers and Supports for Plumbing Piping” for insulation shields.
 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 5. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

- G. Hot Pipe Insulation:
 - 1. Provide pipe hangers for hot piping sized for the outside diameter of piping.
 - 2. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints. Seal exposed insulation at hanger with joint sealant.
- H. Pipe insulation:
 - 1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
 - 2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports.
 - 3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section "Hangers and Supports for Plumbing Piping" for insulation shields.
 - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 - 5. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints.
 - 6. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints.
 - 7. For cold pipes, apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.
- I. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves (except balancing and flow control valves), strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Butt tightly against adjoining pieces and bond with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves (except balancing and flow control valves), flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- J. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- K. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
- L. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

3.06 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing Plumbing insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.07 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.08 PIPING SYSTEM INSULATION SCHEDULE

- A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.
- B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.
- C. Omit insulation on the following:
 1. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.
 2. Chrome-plated exposed piping
 3. Water Hammer Arrestors
 4. Balancing and flow valves
 5. Buried piping

6. Pre-insulated equipment.
7. Cold water piping
8. Condensate piping
- D. Cold Piping (minimum operating temperature less than 60 degrees F.)
 1. Service
 - a. Potable cold water piping.
 - b. Horizontal interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
 - c. Horizontal and vertical interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
 - d. Horizontal and vertical interior above-ground overflow storm drainage piping and vertical run from roof drain to horizontal run. Where vertical overflow storm drainage piping from the outlet exceeds 15 feet, only insulate within 15 feet of the outlet.
 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Mineral fiber.
 - b. Flexible elastomeric.
- E. Hot Temperature Piping (105 degrees to 180 degrees F (40 to 82 degrees C)):
 1. Service:
 - a. Hot water supply and return piping.
 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Mineral fiber.
 - b. Flexible elastomeric.

3.09 PIPE INSULATION THICKNESS SCHEDULE

- A. Piping Inside Masonry Wall Units:
 1. Insulate cold, hot, and hot water recirculation piping installed inside of masonry walls where the piping needs to be insulated as the wall is constructed as described below:
 - a. Flexible Elastomeric: 1/2" thick for pipe sizes up to and including 2", 1" thick for pipe sizes 2-1/2" to 6" (largest size permitted).
- B. IECC – 2021 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness			Nominal Pipe or Tube Size (in.)					
	Insulation Conductivity		Mean Rating Temp., °F.						
	Conductivity, Btu·in./(hr·ft²·°F)								
				<1	1 to	1-1/2	4 to	≥8	
				<1-1/2	to <4	<8			
				Insulation Thickness, in.					
141°F–200°F	0.25–0.29		125	1.5	1.5	2.0	2.0	2.0	
105°F–140°F	0.21–0.28		100	1.0	1.0	1.5	1.5	1.5	
40°F–60°F	0.21–0.27		75	0.5	0.5	1.0	1.0	1.0	

Notes:

1. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
2. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} - 1]$ where
 - a. T = minimum insulation thickness (in.),
 - b. r = actual outside radius of pipe (in.),

- c. t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
 - d. K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and
 - e. k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- 3. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
 - 4. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.10 PIPING JACKET SCHEDULE

- A. Exposed piping within mechanical rooms (above 10 feet):
 - 1. Semi-rigid PVC.
 - 2. Rigid aluminum shell.
- B. Exposed piping:
 - 1. All-service jacket.
 - 2. Semi-rigid PVC.
- C. Piping within return air plenums:
 - 1. All-service jacket.

END OF SECTION 22 0700

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SECTION 22 1100
WATER DISTRIBUTION PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties within the building to a point 5 feet outside the building.
- B. Contractors Option:
 - 1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves, and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined water distribution piping systems where used shall be provided in compliance with specification Section 221111 "Mechanically Joined Plumbing Piping Systems".
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 2. Division 22 Section "Identification for Plumbing Piping and Equipment" for labeling and identification of water distribution piping.
 - 3. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.
 - 4. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, dielectric unions, dielectric flanges, and mechanical sleeve seals.
 - 5. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.
 - 6. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials, and methods for hanging and supporting water distribution piping.
 - 7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.
 - 8. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties," for material and methods for trap primer outlet piping.

1.02 DEFINITIONS

- A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.
- B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.
- C. Pipe sizes used in this Specification are nominal pipe size (NPS).
- D. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specifications Sections.

1. Product data for each piping specialty and valve specified.
2. Welder Certificates signed by Contractor certifying that welders comply with requirements specified in Article "Quality Assurance" below.
3. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
4. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."
5. Test reports specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- B. Regulatory Requirements: Comply with the provisions of the following codes:
 1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
 2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.
- C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.
- D. Pipe, fittings, and specialties shall be manufactured in the United States or be certified to meet ASTM and ANSI standards.

1.05 SPARE PARTS

- A. Maintenance Stock: Furnish one valve key for each key-operated wall hydrant, hose bibb, fixture supply, or faucet installed.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Plumbing Pipe Support Brackets
 - a. Holdrite
 - b. PROFLO
 - c. Sioux Chief
 2. Roof Hydrants
 - a. Jay R. Smith Mtg Co.
 - b. Mifab Manufacturing, Inc.
 - c. Prier, Inc.
 - d. Woodford Mfg. Co.
 - e. Zurn Industries
 3. Sanitary Roof Hydrants
 - a. Hoeptner Perfected Products
 - b. Jay R. Smith Mtg Co.
 - c. Prier, Inc.

- d. Mapa
- e. Woodford Mfg. Co.

2.02 PIPE AND TUBE MATERIALS, GENERAL

- A. Pipe and Tube: Refer to Part 3, Articles "Above Ground Water Distribution Pipe and Fittings" or "Below Ground Water Distribution Pipe and Fittings", for identification of systems where the materials listed below are used.
- B. Copper Tube: ASTM B88, Type L Water Tube, drawn temper.
- C. Steel Pipe: ASTM A53, Type E or S, schedule 40, Grade B, galvanized, threaded ends.
- D. Brass Pipe: Chrome Plated Schedule 40 ASTM B43 iron pipe size (IPS.)

2.03 FITTINGS

- A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.
- B. Galvanized Malleable Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ASME B1.20.1.
- C. Ductile or Gray-Iron Flanged Fittings: AWWA C110 Class 125 with AWWA C116 epoxy coating inside and outside.
- D. Brass Fittings: Chrome plated ANSI B16, Class 125 with threaded connections.
- E. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125, raised ground face, bolt holes spot faced.
- F. Bronze Flanges: ANSI B16.24, Class 150, raised ground face, bolt holes spot faced.

2.04 JOINING MATERIALS

- A. Solder Filler Metal: ASTM B32 Alloy Sb-5, 95-5 Tin-Antimony.
- B. Brazing Filler Metals: AWS A5.8, Bag-7 Silver.
- C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and design temperatures and pressures.

2.05 PIPING SPECIALTIES

- A. Pipe Support Brackets:
 - 1. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of 1/2" on 2" centers and holes of 3/4" or 1" on 4" centers.
 - 2. Pipe Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent pipe in wall.
 - 3. Carrier Bracket: 20 gauge copper bracket with 1" hole for supporting rough-in for flush valve copper tube and bolt slot for attaching to chair carrier.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install piping, valves and specialties in accordance with manufacturer's installation instructions.

3.02 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS

- A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 8 inches and smaller, within the building.

3.03 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

- B. Use fittings for all changes in direction and branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.
- I. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- J. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves packing, and sealant. Refer to Division 22 Section "Basic Piping Materials and Methods" for additional information.
- K. Install piping with 1/32-inch-per-foot (1/4 percent) downward slope towards drain point.
 - a. Install piping level with no pitch.

3.04 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Pipe Attachments: Install the following:
 - 1. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs. Provide copper coated riser clamps when in contact with copper tube.
 - 3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Supports and Anchors" and "Plumbing Insulation".
 - 4. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls and for securing 1-1/4" to 2" copper tube inside walls and chases for battery fixtures. Secure clamp to the copper tube.
 - a. Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section "Plumbing Insulation" for requirement for maintenance of the vapor barrier and vapor barrier seal method.
 - 5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of stainless steel tube 2" and smaller on walls or for securing tube inside walls for connection to faucets.
 - 6. Support copper tube in chases and walls at plumbing fixtures with plastic or copper brackets secured to structure and U-bolts sized to bare on the pipe.
 - 7. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube. Provide two piece straps and

360° insulation protection shields sized for the insulation thickness used for the pipe for all insulated pipes.

8. Secure copper tube rough-in for individual fixtures with sheet stud brackets attached to the wall studs or pipe mounting brackets attached to the fixture waste & vent pipe at each plumbing fixture.
 9. Secure 1" and smaller copper water tubing in stud walls at stud penetrations with tube suspension clamps.
 - a. Cut hole through non-supporting studs with a minimum 1/8" clearance around each uninsulated copper tube or insulated copper tube.
 - b. Seal each joint of insulation and tube suspension clamp to maintain the insulation barrier. Refer to Division 22 "Plumbing Insulation" for requirement for maintenance of the vapor barrier similar to insulation butted against insulation inserts and vapor barrier seal method.
 10. Provide roll hangers for individual horizontal runs 100 feet or longer.
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 4	12	10	3/8
5	12	10	1/2
6	12	10	1/2
8	12	10	1/2

- D. Support water piping within 12" of each elbow or tee and for water piping 2-1/2" and larger at each valve or strainer.
- E. Support water piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

3.05 PIPE AND TUBE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
 1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.
 2. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
 3. Heat joints to proper and uniform temperature.
- C. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:
 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

- a. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- D. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- E. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Provide dielectric waterway fittings for 2" and smaller in concealed locations. Dielectric unions, waterway fittings and flanges are specified in Section "Basic Piping Materials and Methods".
- F. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

3.06 FIELD QUALITY CONTROL

- A. Inspections: Inspect water distribution piping as follows:
 - 1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
 - 2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
 - d. Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.
- B. Piping System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 - 1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 - 2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
 - 3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
 - 5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.07 ADJUSTING AND CLEANING

- A. Clean and disinfect water distribution piping as follows:
 - 1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.
 - 2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not proscribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:
 - a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
 - b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.
 - c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
 - d. Following the allowed standing time, flush the system with clean, potable water until chlorine residual is lowered to incoming city water level.
 - e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.
 - 3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

END OF SECTION 22 1100

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SECTION 22 1300
SANITARY DRAINAGE AND VENT PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.01 SUMMARY

- A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 3. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.
 - 4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
 - 5. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
 - 6. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.
 - 7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

1.02 DEFINITIONS

- A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer.
- B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for the following products:
 - 1. Drainage piping
 - 2. Drainage piping specialties
 - 3. No-hub fitting restraints
- C. Test reports specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following codes:
1. 2018__ International Plumbing Code

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Drainage Piping Specialties, including backwater valves, expansion joints, cleanouts, floor drains, cast-iron trench drains and vandal-proof vent caps:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Mfg. Co.
 - c. Mifab Manufacturing Co.
 - d. Sioux Chief Manufacturing Co. Inc.
 - e. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - f. Watts Industries, Inc.
 - g. Zurn Industries, Inc.; Hydromechanics Div.
 2. Heavy Duty Hubless Couplings
 - a. Anaco Husky HD-2000
 - b. Clamp-All 80in. lb.
 - c. Ideal Tridon "HD"
 - d. Mifab Manufacturing, Inc. #MI-XHUB-series
 - e. Mission Rubber Company, "Heavy Weight"
 - f. ProFlo "HD"
 3. Shielded Transition Couplings
 - a. FERNCO, "Proflex 3000 Series"
 - b. Anaco-Husky #SD-4200
 - c. Mission Rubber Company, "Band Seal Specialty Couplings"
 4. Hubless Couplings:
 - a. Anaco
 - b. Ideal Tridon
 - c. Mifab Manufacturing, Inc. #MI-HUB- series
 - d. Mission Rubber Company
 - e. ProFlo "PFNH"
 - f. Tyler Pipe / Soil Pipe Division
 5. No-Hub Fitting Restraints
 - a. Holdrite
 6. PVC DWV Expansion Joints
 - a. Charlotte Pipe and Foundry Company #133
 - b. Spears Manufacturing Company #S119

2.02 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

- A. Refer to Part 3, Article "Pipe Applications - Above Ground, Within Building" for identification of systems where the materials listed below are used.
- B. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, no-hub pipe and fittings and bearing the trademark of CISPI and NSF.
 - 1. Couplings and compression gaskets, NSF certified: ASTM C564 and CISPI 310.
 - 2. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.
- C. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.
 - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- D. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.
 - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- E. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
 - 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
 - 2. Solvent: ASTM D2564.
- F. PVC Pressure Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 with "solid wall" PVC meeting ASTM D1784 with cell class 12454.
 - 1. Solvent: ASTM D2564.
 - 2. Fittings: Schedule 40 meeting ASTM D2466 with solvent cement socket joints.
- G. Steel Pipe: ASTM A53, Type E or S, schedule 40, Grade B, galvanized, threaded ends.
 - 1. Galvanized Malleable Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ASME B1.20.1.
- H. "Flowguard Gold" CPVC Water Distribution Tube (1/2" to 2"): ASTM D2846, Copper Tube Size (CTS), pipe with a cell class of 24448 as identified in ASTM 1784. NSF 14 certified and NSF 61 listed. Meeting ASTM E84 for 25 / 50 flame / smoke rating.
 - 1. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.
- I. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.03 PVC DWV EXPANSION JOINTS

- A. Schedule 40 PVC DWV meeting ASTM D2665 with socket connections and telescoping expansion joint with EPDM O-ring seal.

2.04 NO-HUB FITTING RESTRAINTS

- A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.02 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

- A. Install hubless, cast-iron soil pipe and fittings for 15" and smaller soil, waste, and vent pipe.

- B. Install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings, copper sweat X screwed with solder joints, for waste connections from urinals, lavatories, sinks, water coolers, and kitchen equipment to cast iron drainage piping.
- C. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller, with 3/4" minimum size and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4" and larger for waste connections from kitchen equipment and terminate over floor receptors with air gap.
- D. .

3.03 PIPE AND TUBE JOINT CONSTRUCTION

- A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."
- B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:
 - 1. Install hubless couplings complying with CISPI 310 on soil, waste and vent piping.
 - 2. Install hubless couplings complying with CISPI 310 on and soil and waste piping 3" and smaller and all vent piping.
 - 3. Install heavy duty hubless couplings on soil or waste stacks, soil and waste piping connections to soil or waste stacks and all soil and waste piping 4" and larger.
 - 4. Install No-Hub fitting restraints on joints 5" and larger at:
 - a. Changes of direction from vertical to horizontal
 - b. 4" branch connections, including tees, wyes and wye combination fittings to soil and waste piping 5" and larger
 - c. Horizontal changes of direction 22-1/2 degrees and greater
 - d. Changes in diameter of two pipe sizes or greater.
- C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.
- D. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.
- E. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.

3.04 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Paint exposed copper drain lines serving kitchen equipment with a minimum of two coats of chromium-based paint.

- H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section "Basic Piping Material and Methods" for special sealers and materials.
- I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Basic Piping Material and Methods" for special sealers and materials.
- J. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.
- K. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger. [Install all drainage piping upstream of grease interceptors at a minimum slope of 1/4 inch per foot.] Install vent piping pitched to drain back by gravity to the sanitary drainage piping system.

3.05 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".
 - a. Install high density insulation on insulated pipe.
 - 3. Provide vinyl coated hangers and riser clamps for use with PVC pipe and CPVC CTS tube.
 - 1. Provide roll hangers for individual horizontal runs 100 feet or longer.
 - 2. Provide ceiling flanges attached to the floor, all thread rod and split ring pipe clamps for indirect drains and condensate drains supported from the floor 2" and smaller.
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size – In.	Steel Pipe Max. Span – Ft.	Copper Tube Max. Span – Ft.	Min. Rod Dia. - In.
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 4	12	10	3/8
5	12	10	1/2
6	12	10	1/2
8	12	10	1/2
10 to 12	12	10	5/8
14 to 15	12	N/A	3/4

Nom. Pipe Size <u>In Inches.</u>	CTS CPVC Tube <u>Max. Span - Ft.</u>	CPVC Tube Min. Rod <u>Dia. - In.</u>
1/2	3	3/8
3/4	3	3/8
1	3	3/8
1-1/4	4	3/8
1-1/2	4	3/8
2	4	3/8

1. Support all sizes of horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide support at each horizontal branch.
 2. Support all sizes of horizontal of PVC piping every four feet.
 3. Support piping within 12" of each elbow or tee.
- D. Sway bracing:
1. Provide rigid sway bracing for pipe 4" and larger at changes of direction greater than 45 degrees.
 2. Secure horizontal base of stack to structure with riser clamp within at the fitting changing direction of flow from vertical to horizontal. Provide rods of size equal to cast iron pipe size scheduled above in pipe hanger schedule.

3.06 CONNECTIONS

- A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.07 FIELD QUALITY CONTROL

- A. Inspections
 1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
 2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspection by the plumbing official.
 - d. Reports: Prepare inspection reports, signed by the plumbing official.
- B. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1" water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.
5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.08 ADJUSTING AND CLEANING

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.09 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 22 1300

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END OF SECTION 23 0000

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SECTION 23 0010
GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.02 QUALITY ASSURANCE

- A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.03 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

BOCA	Building Officials Code Administration
IBC	International Building Code
IMC	International Mechanical Code
IPC	International Plumbing Code
IECC	International Energy Conservation Code
IFC	International Fire Code
ADA	American Disabilities Act
ADC	Air Diffusion Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.04 DEFINITIONS

A. General:

1. **Furnish:** The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
2. **Install:** The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. **Provide:** The term "provide" means "to furnish and install, complete and ready for the intended use. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary

for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. 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.
 - b. 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.
9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.05 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

- D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate the work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.06 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of 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 trade.
 - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
 - 4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - 5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
 - 6. Indicate required installation sequence to minimize conflicts between entities.
 - 7. 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 Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 - 8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. 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. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.

3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.07 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.08 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

- K. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.
- M. Provide welders' qualification certificates.

1.09 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.

- e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
 - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 - 2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
 - 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 - 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain data listed in each individual Section.
- F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representative.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification.

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

- A. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.
- D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

- A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
- C. The following additional items shall be guaranteed:
 - 1. Piping shall be free from obstructions, holes or breaks of any nature.
 - 2. Insulation shall be effective.
 - 3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.18 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting their bid to determine the nature and extent of work involved.
2. Work in the existing building shall be scheduled with the Owner.
3. Certain demolition work must be performed prior to the remodeling. The Mechanical Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.
4. Mechanical Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Mechanical Contractor during this demolition shall become their property and shall be removed by the Mechanical Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
5. Mechanical Contractor shall relocate and reconnect Mechanical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Mechanical equipment or materials are removed, the Mechanical Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
6. General Contractor shall install finish material.
7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
9. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

- B. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.01 NOT USED

PART 3 - EXECUTION

3.01 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.02 EXISTING UTILITIES

- A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.
- B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

- C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.
- D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.
- E. Contractor shall include in their bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.03 SELECTIVE DEMOLITION

- A. Refer to Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment to Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- E. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, and insulation.
 - a. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 23.
- F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - 1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.04 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.05 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.

- B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.06 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 - 1. Submit complete Operation and Maintenance Manuals.
 - 2. Submit complete Record Drawings.
 - 3. Perform special inspections as required in each individual Section.
 - 4. Start-up testing of systems.
 - 5. Removal of temporary facilities from the site.
 - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, the Contractor shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 23 0010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples
☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

Similar Installation: _____

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No	
Additional Comments:	☐ Attached	☐ None	

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

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SECTION 23 0015
ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.
- C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.02 SUBMITTALS

- A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.03 QUALITY ASSURANCE

- A. Electrical components and materials shall be UL labeled.
- B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.
- B. Refer to Division 26, "COMMON WORK RESULTS FOR ELECTRICAL" for specification of motor connections.
- C. Refer to Division 26, "ENCLOSED CONTROLLERS" for specification of motor starters.
- D. Refer to Division 26, "ENCLOSED SWITCHES AND CIRCUIT BREAKERS" for specification of disconnect switches and enclosed circuit breakers.

PART 3 - EXECUTION

3.01 CONTRACTOR COORDINATION

- A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.
- B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the

General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV23m	DIV23m	DIV26	---
Factory furnished motor starters contactors and disconnects	DIV23m	DIV23m	DIV26	DIV23t
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV26	DIV26	DIV26	DIV23t
Variable speed drives	DIV23m	DIV23m	DIV26	DIV23t
Control relays	DIV23t	DIV23t	DIV26	DIV23t
Thermostats (low voltage)	DIV23t	DIV23t	---	DIV23t
Thermostats (line voltage)	DIV23m	DIV23m	DIV26	---
Control power transformers	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers furnished with equipment	DIV23m	DIV23m	DIV26	DIV23t
Temperature control panels (housing controllers)	DIV23t	DIV23t	DIV26	DIV23t
Building controllers, advanced application controllers, and application specific controllers	DIV23t	DIV23t	DIV23t	DIV23t
Motor and solenoid operated valves	DIV23t	DIV23m	DIV23t	DIV23t
Damper operators, PE & switches	DIV23t	DIV23t	DIV23t	DIV23t
Smoke dampers and combination fire/smoke dampers	DIV23m	DIV23m	DIV26	DIV28
Control dampers	DIV23t	DIV23m	DIV26	DIV23t
Duct Smoke detectors	DIV28	DIV23m	DIV28	DIV28
Temporary heating connections	DIV23m	DIV23m	DIV26	DIV23m

DIV23m = Mechanical Contractor

DIV23t = Temperature Controls Sub-Contractor

DIV26 = Electrical Contractor

DIV28 = Electronic Safety and Security

END OF SECTION 23 0015

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SECTION 23 0500
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.
- B. Mechanical equipment nameplate data.
- C. Miscellaneous metals for support of mechanical materials and equipment.
- D. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.
- E. Joint sealers for sealing around mechanical materials and equipment.
- F. Sealing penetrations through noise critical spaces.
- G. Firestopping

1.02 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 23 Section General Mechanical Requirements.
 - 1. Product data for the following products:
 - a. Access panels and doors.
 - b. Joint sealers.
 - c. Through and membrane-penetration firestopping systems.
 - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
 - 3. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."
 - 4. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.03 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.

- C. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.04 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

Space	RC Levels
Sound/Lighting Control Rooms	25
A/V Spaces	25
Broadcast Studio	25
Conference Rooms	30
Courtrooms	30

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCESS TO EQUIPMENT

- A. Refer to Architectural documents for specification of Access Panels and Access Doors.

2.02 MECHANICAL EQUIPMENT NAMEPLATE DATA

- A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.03 GROUT

- A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.
- B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.
- C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.04 PENETRATIONS

- A. Sleeves:
1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
- B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.05 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

2.06 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPB rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

2.07 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.
 - 1. Manufacturers:
 - a. Dow Corning, Dowsil 790.
 - b. Dow Corning, Dowsil 795.
 - c. GE, Silglaze II SCS 2350.
 - d. GE, Silpruf SCS 2000.
 - e. Owens Corning, Energy Complete.
 - f. Pecora, 864 NST.
 - g. Tremco, Spectrem 1.
 - h. Tremco, Spectrem 2.
- D. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.
 - 1. Manufacturers:
 - a. BASF, MasterSeal NP 100.
 - b. Pecora, DyanTrol I-XL.
 - c. Tremco, Dymonic FC.
- E. Acrylic Latex Joint Sealer: One-part, non-sag, mildew-resistant, paintable acrylic latex or siliconized acrylic latex, complying with ASTM C834, Type OP, Grade NF, recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
 - 1. Manufacturers:
 - a. Pecora, AC-20
 - b. Sherwin Williams 950A
 - c. Tremco, Tremflex 834

2.08 ACOUSTICAL SEALANTS

- A. General: Penetrations by ducts, pipes and conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
- B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.
- C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
- D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m³).
- E. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90. Meeting ASTM E84 for a smoke flame spread index of less than 25 / 50.
- F. Manufacturers:
 - 1. Pecora, AC-20 FTR.
 - 2. Pecora, AIS-919.
 - 3. USG, SHEETROCK Acoustical Sealant.

2.09 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E814, or other NRTL acceptable to AHJ.
- B. Manufacturers:
 - 1. 3M Corp., Fire Barrier Sealant.
 - 2. Hilti.
 - 3. Owens Corning, Firestopping Insulation.
 - 4. Pecora, AC-20 FTR.
 - 5. RectorSeal.
 - 6. Specified Technologies Inc., Firestop.
 - 7. USG SHEETROCK Firecode Compound.
 - 8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.

3.02 INSTALLATION OF ACCESS DOORS

- A. Provide access doors for all concealed equipment and duct and piping accessories that require service where indicated or as required, except where above lay-in ceilings. Refer to Section "Identification for HVAC Piping and Equipment" for labeling of access doors.
- B. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

- C. Access doors must be of the proper construction for type of construction where installed.
- D. The exact location of all access doors shall be verified with the Architect prior to installation.
- E. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- F. Adjust hardware and panels after installation for proper operation.

3.03 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.04 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.05 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.06 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.07 PENETRATIONS:

- A. Construction in Existing Facilities:
 - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
- B. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.
- C. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.
- D. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.
- E. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

- F. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Extend sleeves installed in floors 2 inches above finished floor level.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

3.08 ACOUSTICAL PENETRATIONS

- A. General: There shall be no direct contact of Sheet Metal or piping with shaft walls, floor slabs and/or partitions. All openings around pipes and ducts in the structure surrounding the mechanical equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein.. This includes all slab penetrations and penetrations of noise critical walls.
- B. Duct Penetrations: Where each duct passes through a wall, floor or ceiling of a noise critical space, there shall be a clear annular space of 1 inch between the duct and structure. After all of the ductwork is installed, the Contractor shall check the clearance, pack the voids full depth with packing material and caulk both ends with non-hardening sealant backed by foam rod or permanently flexible firestop material. Where there is not sufficient access space to pack around all sides of a duct (for example, at the underside of a slab), place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.
- C. HVAC Piping:
 - 1. Provide a steel sleeve cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, verify the specified clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.
 - 2. Provide factory fabricated split seal clamp around the pipe filled with closed-cell neoprene sponge insulation, thickness as required to match adjacent insulation, minimum 3/4 inch. Cast or grout the sleeve into the structure. Provide fiberglass insulation if the pipe is subject to temperatures greater than 225 degrees F. Provide Mason Industries Type SWS or approved equal.

END OF SECTION 23 0500

SECTION 23 0510
BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

- A. Joining materials.
- B. Nipples.
- C. Unions.
- D. Dielectric unions.

1.02 SUBMITTALS

- A. Refer to Division 01 and Division 23 Section "General Mechanical Requirements" for administrative and procedural requirements for submittals.
- B. Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.
- C. Quality Assurance Submittals: Submit welders' certificates specified in Article "Quality Assurance" below.
- D. Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system application in the project including manufacturer's catalog information, pipe materials, sizes, fittings, Type, Grade, Schedule, applicable ASTM standard, and connection method(s).
- E. Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.
- F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.
- G. Manufacturer's Installation Instructions: Indicate hanging and support methods and joining procedures.
- H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- I. Shop Drawings: Include detailed fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.
- J. Coordination Drawings: Include piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Other building services.
 - 3. Structural members.
- K. As-built drawings for each piping system in electronic and PDF format.
- L. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.03 QUALITY ASSURANCE

- A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code (BPVC), Section IX, "Welding, Brazing, and Fusing Qualifications."
- B. Comply with ASME B31.9 - Building Services Piping, most recent edition.
- C. Comply with American Welding Society (AWS), Welding Handbook, most recent edition.

- D. Soldering and Brazing procedures shall conform to ANSI B9.1 Safety Code for Mechanical Refrigeration.
- E. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ASME, and ANSI standards.
- F. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- C. Refer to the individual piping system specification sections in Division 23 for additional requirements.

PART 2 - PRODUCTS AND MATERIALS

2.01 PIPE AND FITTINGS

- A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.02 JOINING MATERIALS

- A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Welding Materials: Comply with AWS D10.12 and Section II, Part C, ASME BPVC for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- D. Brazing Filler Metals: Comply with SFA-5.8, Section II, ASME BPVC for brazing filler metal materials appropriate for the materials being joined.
 - 1. AWS A5.8, Classification BAg-5:
 - a. Silver (Ag) 44.0 – 46.0 percent.
 - b. Zinc (Z) 23.0 – 27.0 percent.
 - c. Copper (Cu) 29.0 – 31.0 percent.
 - 2. AWS A5.8, Classification BCuP-5:
 - a. Phosphorus (P) 4.8 - 5.2 percent.
 - b. Silver (Ag) 14.5 - 15.5 percent.
 - c. Copper (Cu) remainder.
- E. Soldering Filler Metals: ASTM B32, 95-5 Tin-Antimony and water flushable flux in accordance with ASTM B813.
- F. Plastic Pipe Solvent Cement:
 - 1. PVC: ASTM D2564.
 - 2. CPVC: ASTM F493.
- G. Gaskets for Flanged Joints: ASME B16.21, full-faced for cast-iron flanges and raised-face for steel flanges. Select material, thickness, and type to suit the service of the piping system in which installed and which conform to their respective ASME Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.03 NIPPLES

- A. Steel: ASTM A733, made of ASTM A53, Schedule 40, black steel; Type S seamless for pipe sizes 2 inch and smaller, Type E electric-resistance welded for pipe sizes 2-1/2 inch and larger.

2.04 UNIONS:

- A. Manufacturers:
 - 1. Anvil International.
 - 2. Hart Industries.
 - 3. Mueller Streamline Co.
 - 4. Victaulic Company of America.
 - 5. Watts Regulator Co.
 - 6. Approved equal.
- B. Hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
 - 1. Malleable-iron: ASME B16.39, class as specified in section "Hydronic Piping" for the piping system used.
 - 2. Bronze: ASME B16.15, cast bronze body meeting ASTM B62, class as specified in section "Hydronic Piping" for the piping system used.
 - 3. Copper: ASME B16.22 wrought copper body.
 - a. For hydronic systems, provide class as specified in section "Hydronic Piping" for the piping system used.
 - b. For refrigerant systems, provide pressure rating as required for the refrigerant type used.

2.05 DIELECTRIC UNIONS

- A. Manufacturers:
 - 1. Hart Industries.
 - 2. Victaulic Company of America.
 - 3. Watts Regulator Co.
 - 4. Approved equal.
- B. Factory-fabricated with cast bronze body meeting ASTM B584 and galvanized or black steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.02 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical,

install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

- C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations. Provide deep pattern escutcheons where required to conceal protruding pipe fittings.
- D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.
- J. Verify final equipment locations for roughing in.
- K. Use fittings for all changes in direction and all branch connections.
- L. Remake leaking joints using new materials.
- M. Install components with pressure rating equal to or greater than system operating pressure.
- N. Piping Protection:
 - 1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
 - 2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.03 PENETRATIONS

- A. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies. Reference Division 23 Section "Common Work Results for HVAC" for additional penetration requirements.
- B. Above Grade Concrete or Masonry Penetrations:
 - 1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs.
 - a. Provide Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
 - b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
 - c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).
 - 2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

- d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
 2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.
 3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.
- C. Interior Penetrations of Non-Fire-Rated Walls:
1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.
- D. Fire / Smoke Rated Floor and Wall Assemblies:
1. Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 07 Section "Penetration Firestopping" for special sealers and materials.
- E. Acoustical Barrier Penetrations:
1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The internal diameter of the sleeve shall be minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.
 2. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.04 PIPE JOINT CONSTRUCTION

- A. Threaded Joints:
1. Provide tapered pipe threads for field cut threads. Cut threads full and clean using sharp dies.
 2. Ream threaded pipe ends to remove burrs and restore full inner diameter.
 3. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine how far pipe should be threaded into joint.
 4. Align threads at point of assembly.
 5. Apply appropriate tape or thread compound to the male pipe threads except where dry seal threading is specified.
 6. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded. Tighten joint to leave not more than 3 threads exposed.
 7. Damaged Threads: Do not use pipe or pipe fittings with threads which are corroded or damaged.
- B. Welded Joints:
1. Comply with the requirement in ASME Code B31.9, "Building Services Piping."
 2. Damaged Welds: Do not use pipe sections that have cracked or open welds.

C. Brazed and Soldered Joints:

1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
2. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
3. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
4. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
1. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making joint.
2. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
5. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.
6. Dissimilar metals such as copper and brass shall be jointed using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.
7. Continuously purge the pipe and fittings during brazing with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.
8. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
9. Provide temporary cap or cover on completed joints with open ends to prevent entry of contaminating materials.

D. Socket Joints:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Prepare surfaces to be solvent cemented by wiping with a clean cloth moistened with acetone or methylethyl ketone.
3. CPVC Joints: Solvent cement joints in accordance with ASTM D2846.
4. PVC Joints: Solvent cement joints in accordance to ASTM D2672.

B. Joints for other piping materials are specified within the respective piping system Sections.

3.05 UNIONS

- A. Install unions on pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

3.06 DIELECTRIC UNIONS

- A. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:
1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
- B. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:
1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
 2. Install waterway fittings where installation is concealed. Do not install dielectric unions in concealed spaces.

3.07 PIPE FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.

END OF SECTION 23 0510

**SECTION 23 0513
COMMON MOTOR REQUIREMENT FOR HVAC EQUIPMENT**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Electronically Commutated Motors (ECM).
- D.

1.02 SUBMITTALS

- A. Conform with the submittal procedures in Division 01.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Provide nameplate data and ratings, mounting arrangements, size and location of winding termination lugs, overload relays, conduit entry, grounding lug, and coatings.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.03 QUALITY ASSURANCE

- A. Comply with NFPA 70 National Electrical Code.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.04 DELIVERY STORAGE AND HANDLING.

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.05 WARRANTY

- A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Baldor Electric Company.
- B. General Electric.
- C. Gould.
- D. Marathon.
- E. Regal-Beloit Corporation (Century).
- F. Westinghouse

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.
 - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
- B. Construction:
 - 1. Open drip-proof except where noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 4. Motors with frame sizes 254T and larger: Energy Efficient Type.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.03 APPLICATIONS

- A. Exception: Motors less than 250 Watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.
- B. Single phase motors for fans less than 1 hp and greater than 1/12 hp: Electronically commutated type.

2.04 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.
- B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.
- C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.
- D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install securely on firm foundation.
- C. Check line voltage and phase and ensure agreement with nameplate.
- D. Install motor overload relays in a common enclosure adjacent to the variable frequency drive

3.02 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

<u>HP</u>	<u>3600 RPM</u>	<u>1800 RPM</u>	<u>1200 RPM</u>	<u>900 RPM</u>
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15

END OF SECTION 23 0513

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SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges and fittings.
- B. Thermometers and thermometer wells.
- C. Test plugs.

1.02 SUBMITTALS

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Product Data: Provide schedule that indicates the following for each manufactured component:
 - 1. Model or figure number.
 - 2. Use.
 - 3. Rating.
 - 4. Operating range.
 - 5. Total range.
 - 6. Calibrated performance curves, certified where indicated.
 - 7. Figure number.
 - 8. Location.
 - 9. Accessories.
- C. Product Certificates: Signed by manufacturer certifying accuracy under specified operating conditions and product compliance with specified requirements.
- D. Samples: Submit two of each type of instrument specified.
- E. Project Record Documents: Record actual locations of components and instrumentation.
- F. Operation and Maintenance Data: Furnish data for each manufactured component for inclusion in operating and maintenance manual.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Pressure Gauges: One of each type and size.

1.03 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Ametek, U.S. Gauge Div.
 - 2. Ashcroft Dresser Industries Instrument Div.
 - 3. Dwyer Instruments, Inc.
 - 4. H.O. Trerice Co.
 - 5. Marsh Instrument Co., Unit of General Signal.
 - 6. Marshalltown Instruments, Inc.

7. Miljoco Corp.
 8. Weiss Instruments, Inc.
 9. Weksler Glass Thermometer Corp.
 10. WIKA Instruments Corp.
 11. Winters Instruments.
- B. Description: ASME B40.100, UL 393, rotary brass movement, white with black markings and black pointer.
- C. Case: Drawn steel, cast aluminum, or stainless steel with phosphor bronze bourdon tube and front or rear recalibration adjustment. Provide silicone fluid damping where required by Part 3.
- D. Size: 4-1/2 inch diameter.
- E. Lens: Clear glass.
- F. Stem: Brass for separable socket, length to suit installation.
- G. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.
- H. Accuracy: Plus or minus 1 percent of range span.
- I. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

2.02 PRESSURE GAUGE TAPPINGS

- A. Manufacturers: Same as pressure gauge manufacturers.
- B. Gauge Cock: Tee or lever handle, brass, rated for system pressure.
- C. Needle Valve: Brass, 1/4 inch NPT, rated for system pressure.
- D. Pulsation Damper: Pressure snubber, brass with 1/4 inch threaded connections, corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.
- E. Syphon: Brass, 1/4-inch NPT angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
1. Dwyer Instruments, Inc.
 2. H.O. Trerice Co.
 3. Marsh Instruments, Inc.
 4. Miljoco Corp.
 5. Weiss Instruments, Inc.
 6. Weksler Glass Thermometer Corp.
 7. Winters Instruments.
- B. Thermometers - Adjustable Angle:
1. Description: Red- or blue-appearing non-toxic liquid in glass tube; .
 2. Adjustable Joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 3. Case: Cast aluminum with enamel finish.
 4. Size: 9 inch scale.
 5. Window: Clear Lexan.
 6. Stem: Brass, copper-plated steel, or aluminum for separable socket, length to suit installation.
 7. Scale: Progressive, satin-faced, non-reflective aluminum, with permanently etched markings.

8. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.
9. Calibration: Degrees F.

2.04 DIAL THERMOMETERS

A. Thermometer – Direct Mount, Bimetal Actuated:

1. Manufacturers:
 - a. Ashcroft Dresser Industries Instruments Div.
 - b. H.O. Trerice Co.
 - c. Marshalltown Instruments, Inc.
 - d. Miljoco Corp.
 - e. Tel-Tru Manufacturing Co., Inc.
 - f. Weiss Instruments, Inc.
 - g. Weksler Glass Thermometer Corp.
 - h. Winters Instruments.
2. Description: Dial type, ASTM E1 bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer.
3. Adjustable joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
4. Case: Stainless steel with front or rear recalibration.
5. Size: 5 inch diameter dial.
6. Lens: Clear glass, hermetically sealed.
7. Stem: Stainless steel for separable socket. Length to suit installation.
8. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.
9. Accuracy: Plus or minus 1.0 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.
10. Calibration: Degrees F.

B. Thermometers – Direct Mount, Vapor Actuated:

2. Manufacturers:
 - a. Ashcroft Dresser Industries Instruments Div.
 - b. H.O. Trerice Co.
 - c. Miljoco Corp.
 - d. Weiss Instruments, Inc.
 - e. Weksler Glass Thermometer Corp.
 - f. Winters Instruments.
2. Description: Dial type vapor or liquid actuated; ASTM E1; copper bulb, copper or phosphor bronze bourdon tube, white with black markings and black pointer.
3. Adjustable joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
4. Case: Drawn steel, cast aluminum, or stainless steel.
5. Size: 4-1/2 inch diameter dial.
6. Lens: Clear glass.
7. Stem: Brass, copper-plated steel, or aluminum for separable socket. Length to suit installation.

8. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.
 9. Accuracy: Plus or minus 1.0 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.
 10. Calibration: Degrees F.
- C. Thermometers – Remote Reading:
3. Manufacturers:
 - a. Ashcroft Dresser Industries Instruments Div.
 - b. H.O. Trerice Co.
 - c. Miljoco Corp.
 - d. Tel-Tru Manufacturing Co., Inc.
 - e. Weiss Instruments, Inc.
 - f. Weksler Glass Thermometer Corp.
 - g. Winters Instruments.
 2. Description: Dial type vapor or liquid actuated; ASTM E1; white with black markings and black pointer.
 3. Case: Drawn steel, cast aluminum, or stainless steel.
 4. Size: 4-1/2 inch diameter dial.
 5. Lens: Clear glass.
 6. Bulb: Copper for separable socket for liquids, averaging element for air.
 7. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.
 8. Capillary: Copper or bronze double-braided capillary for separable socket. Length to suit installation, minimum 5 feet.
 9. Accuracy: Plus or minus 1.0 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.
 10. Calibration: Degrees F.

2.05 THERMOMETER SUPPORTS

- A. Thermowell Socket: ASTM A536 ductile iron, brass, or stainless steel, compatible with adjacent piping to eliminate dielectric corrosion, with separable socket for thermometer stems and 2 inch extension for insulated piping, pressure rated to match piping system design pressure, with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.06 TEST PLUGS

- A. Manufacturers:
 1. Flow Design, Inc.
 2. MG Piping Products Co.
 3. Peterson Equipment Co., Inc.
 4. Sisco, A Spedco, Inc. Co.
 5. Watts Regulator.
- B. Test Plug: 1/2 inch nickel-plated brass fitting, rated for 500 psig, extension for insulation, and threaded cap with retention chain for receiving 1/8 inch outside diameter pressure or temperature probe.

- C. Core Material:
 - 1. Neoprene core for temperatures up to 200 degrees F.
 - 2. Nordel core for temperatures up to 350 degrees F.
 - 3. Viton core for temperatures up to 400 degrees F.
- D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauge, one gauge adapter with 1/8 inch probes, two 1 inch bimetal dial thermometers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- C. Install thermometers in air duct systems on flanges.
- D. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- E. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.
- F. Coil and conceal excess capillary on remote element instruments.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- J. Locate test plugs where indicated.

3.02 SCHEDULE

- A. Pressure Gages, Location and Scale Range:
 - 1. Location: Install device at inlet and outlet of each of the following:
 - a.
 - b. After major coils. Reference details on plans.
 - 2. Scale Range:
 - a. Vacuum: 30 inches Hg to 15 psig.
 - b. All fluids: 2 times operating pressure.
- B. Pressure Gage Tappings, Location:
 - 1. Major coils – inlets and outlets.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Location: Install device at inlet and outlet of each of the following:
 - a. After major coils. Reference details on plans.
 - 2. Scale Range:
 - a. Hot Water: 30 to 300 degrees F with 2-degree scale divisions
 - b. Chilled Water: 0 to 100 degrees F with 2-degree scale divisions.

- D. Thermometer Sockets, Location:
 - 1. Reheat coils - inlets and outlets.
- E. Dial Thermometers, Location and Scale Range:
 - 1. Each supply air zone, minus 32 to 150 degrees F.
 - 2. Return air, minus 32 to 150 degrees F.

END OF SECTION 23 0519

SECTION 23 0523
GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Applications.
 - 1. General duty valves common to most mechanical piping systems.
- B. General requirements.
- C. Ball valves.

1.02 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene diene monomer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. SWP: Steam working pressure.
- I. TFE: Tetrafluoroethylene.

1.03 SUBMITTALS

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, pressure and temperature classifications, valve design, body material, seating materials, trim material, dimensions, clearances, rough-in details, weights, support requirements, and piping connections.
- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

1.04 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from a single manufacturer.
 - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
 - 3. Subject to compliance requirements, provide products from one of the manufacturers listed in Valve Schedule in Part 3.
- B. Valves shall be certified to meet the specified ASTM, ASME, ANSI, and MSS standards in Part 2 Products, and as follows:
 - 1. ASME B31.9 for building services piping.
 - 2. ASME B31.1 for power piping.
- C. Welding Materials and Procedures: Conform to .

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - 5. Secure check valves in either the closed position or open position.
 - 6. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
- C. Exercise the following precautions for handling:
 - 1. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products from one of the manufacturers listed in the Valve Schedule in Part 3.

2.02 APPLICATIONS

- A. Provide the following valves for the applications if not indicated on Drawings:
 - 1. Isolation (Hydronic): Ball.
 - 2. Dead-End: Ball.
- B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.
- C. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. 2 NPS and Smaller: Threaded ends.
 - 2. Copper Tube:
 - a. 2 NPS and Smaller: Threaded or solder-joint valve ends.
 - 1) Exception: Solder ends not acceptable for hot water or steam pipe.
- D. Chilled Water Valves:
 - 1. 2 NPS and Smaller:
 - a. Minimum Class: 150.
 - b. Body: Bronze.

- c. Allowable Valve Types:
 - 1) Ball: Two piece. Forged brass body is acceptable to bronze body.
 - a) Brass components.
- E. Heating Hot Water Valves:
 - 1. 2 NPS and Smaller:
 - a. Minimum Class: 150.
 - b. Body: Bronze.
 - c. Allowable Valve Types:
 - 1) Ball: Two piece. Forged brass body is acceptable to bronze body.
 - a) Brass components.

2.03 GENERAL REQUIREMENTS

- A. Mechanically Joined General Duty Valves:
 - 1. Contractor shall not use mechanically joined general duty valves for hydronic piping in lieu of welded, threaded or flanged valves.
- B. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- C. Valve Sizes: Match upstream piping unless otherwise indicated.
- D. Valve Stem Design:
 - 1. Rising stem or rising outside screw and yoke stems.
 - 2. Non-rising stem valves may be used on water systems where headroom prevents full extension of rising stems.
- E. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
 - 2. Handwheels: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller, vinyl-covered.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- F. Valves in Insulated Piping: Provide stem extensions so valve operator extends a minimum of 1/2 inches outside of the insulation and the following features:
 - 1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 2. Memory Stops: Fully adjustable after insulation is installed.
- G. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges: ASME B16.1 for cast iron.
 - 3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5 for steel, ASME B16.24 for bronze.
 - 4. Solder Joint Connections: ANSI B16.18.
 - 5. Grooved End Connections: AWWA C606.
- H. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Power Piping Valves: ASME B31.1.
 - 3. Building Services Piping Valves: ASME B31.9.

- I. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- J. Valve Bypass and Drain Connections: MSS SP-45.
- K. Source Limitations: Obtain each valve type from a single manufacturer.

2.04 BRONZE BALL VALVES

- A. Two Piece, Class 150, bronze trim, for valves 2 inch and smaller:
 - 1. Comply with MSS SP-110.
 - 2. CWP Rating: 600 psi.
 - 3. Body: Bronze, ASTM B584.
 - 4. Trim: Bronze.
 - 5. Ends: Threaded or solder joint.
 - 6. Seats and Seals: PTFE.
 - 7. Stem: Blowout-proof.
 - 8. Ball: Full port, chrome plated brass.
 - 9. Operator: Vinyl-covered steel handle.

2.05 BRASS BALL VALVES

- A. Two Piece, Class 150, brass trim, for valves 2 inch and smaller:
 - 1. Standard: MSS SP-110.
 - 2. CWP Rating: 600 psig.
 - 3. Body Design: Two piece.
 - 4. Body Material: Forged brass, ASTM B283 or DZR forged brass, ASTM B283 UNS No. C48640.
 - 5. Trim: Brass.
 - 6. Ends: Threaded or soldered.
 - 7. Seats: PTFE.
 - 8. Stem: Blowout-proof ,brass.
 - 9. Ball: Chrome plated brass.
 - 10. Port: Full.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. If valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Locate valves for easy access. Provide access doors and fire rated access doors as required.

- C. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- D. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
- E. Install three-valve bypass around each pressure reducing valve using throttling-type valves.
- F. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- G. Install valves in a position to allow full stem movement.
- H. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- I. Valves with soldered end connections:
 - 1. Use solder with a melting point as follows:
 - a. Below 840 degrees F for gate, globe, and check valves.
 - b. Below 421 degrees F for ball valves.

3.03 FIELD QUALITY CONTROL

- A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leak; replace valves if leak persists.

3.04 ADJUSTING AND CLEANING

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

3.05 VALVE SCHEDULE

- A. Bronze Ball Valves – 2 inch and smaller, Class 150:
 - 1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

<u>Manufacturer</u>	<u>Threaded Ends</u>	<u>Solder Ends</u>
Apollo	77C-140	77C-240
Hammond	8301A	8311A
Milwaukee	BA-400	BA-450
Nibco	T-585-70	S-585-70
Watts	LFB6080G2	LFB6081G2

- B. Brass Ball Valves – 2 inch and smaller, Class 150:
 - 1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

<u>Manufacturer</u>	<u>Threaded Ends</u>	<u>Solder Ends</u>
Apollo	77F-100	77F-200
Bray	S51	
Hammond	8901	8911
Kitz Corporation	AKTFLL	CTFLL
Milwaukee	BA-475B	BA-485B
Nexus Valve Inc.	UX-#F-#F	UX-#S-#S
Nibco	T-FP-600A	S-FP-600A
Watts	FBV-3C	FBVS-3C

END OF SECTION 23 0523

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SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components.
- B. Horizontal piping hangers and supports.
- C. Saddles and shields.
- D. Anchors and fasteners.
- E. Miscellaneous materials.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.
- B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.
- C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."
- E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- F. Installer's Qualifications: Include evidence of compliance with specified requirements.
- G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.04 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Field-Welding:
 - 1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 - 2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
 - 3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."
- D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.06 DEFINITIONS

- A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS AND MATERIALS

2.01 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test fluid. Include the weight of the pipe, valves, insulation and piping accessories.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.02 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with MSS SP-58.
 - 2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.

- a. Indoor Dry Locations: Provide painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.
 - b. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
 - e. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.
- B. Metal Channel (Strut) Framing Systems:
 1. Manufacturers:
 - a. Cooper B-Line.
 - b. Ferguson Enterprises/FNW.
 - c. PHD Manufacturing.
 - d. Thomas & Betts Corporation.
 - e. Unistrut, a brand of Atkore International Inc.
 - f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 3. Comply with MSS SP-58, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.
 4. Channel Material:
 - a. Indoor Dry Locations: Provide carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel .
 - b. All nuts, brackets, and clamps shall have the same finish as the channel.
 5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.
 6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.
 7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.
- C. Hanger Rods:
 1. Material:
 - a. Indoor Dry Locations: Zinc-plated steel.
 2. Threaded both ends or continuously threaded.
 3. Minimum Size: Reference piping specification sections for rod thicknesses.
 4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.03 HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Manufacturers:
 1. Armacell.
 2. ASC Engineered Solutions.
 3. Cooper B-Line, Inc.

4. Elite Components.
 5. ERICO/Michigan Hanger Co./Caddy
 6. Ferguson/FNW.
 7. Halfen-DEHA.
 8. Hilti.
 9. National Pipe Hanger Corporation.
 10. PHD Manufacturing.
 11. Piping Technology and Products, Inc.
 12. Power-Strut.
 13. Unistrut.
- B. Single Hangers:
1. Band Hanger: Carbon steel, adjustable band, adjustable swivel.
 2. Split Ring: Carbon steel, adjustable swivel, split ring type.
 3. Clevis Hanger: Carbon steel, adjustable, clevis type.
 4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.
- C. Trapeze and Strut-mounted Supports:
1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
 2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.
- D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:
1. Manufacturers:
 - a. ASC Engineered Solutions.
 - b. Holdrite.
 - c. Klo-Shure.
 2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.
- E. Spring Hangers:
1. Reference Section "Vibration Isolation for HVAC" for spring isolation hangers.
- F. Wall Supports:
1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.
 2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.
- G. Pre-Insulated Supports:
1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. Armacell.
 - c. ASC Engineered Solutions
 - d. Buckaroos, Inc.

- e. Cooper B-Line, Inc.
- f. Pipe Shields, Inc.
- 2. General Construction and Requirements:
 - a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.
 - b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Waterproof calcium silicate insulation shall conform to ASTM C795.
 - d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.
 - e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.
- 3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.04 SADDLES AND SHIELDS

- A. Pipe Covering Protection Saddles:
 - 1. Manufacturers: Same as hanger and supports.
 - 2. Meet MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12 inches and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12 inches long.
- B. Insulation Protection Shield:
 - 1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.
 - 2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
 - 3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
 - 4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in)					
		5	6	7	8	9	10
		Hanger Spacing, (ft)					
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-

- C. 360 Degree Insulation Protection Shield:
 - 1. Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
- D. Plastic Saddles and Shields:
 - 1. Manufacturers:
 - a. Armacell.
 - b. Eaton.

- c. Hydra-Zorb.
- d. PHD Manufacturing.
- e. Zsi Foster.
- 2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.05 ANCHORS AND FASTENERS

- A. Manufacturers:
 - 1. Hilti, Inc.
 - 2. Illinois Tool Works, Inc.
 - 3. Phillips.
 - 4. Powers Fasteners, Inc.
 - 5. Rawl.
 - 6. Simpson Strong-Tie Company Inc.
- B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 1. Concrete: Use preset concrete inserts or expansion anchors.
 - 2. Solid or Grout-Filled Masonry: Use expansion anchors.
 - 3. Hollow Masonry: Use toggle bolts.
 - 4. Hollow Stud Walls: Use toggle bolts.
 - 5. Steel: Use beam clamps.
 - 6. Sheet Metal: Use sheet metal screws.
 - 7. Wood: Use wood screws.
 - 8. Plastic and lead anchors are not permitted.
 - 9. Hammer-driven anchors and fasteners are permitted only as follows:
 - a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
 - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.
- C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - 1. Comply with MFMA-4.
 - 2. Channel Material: Use galvanized steel.
 - 3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
 - 4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rod dimensions.
 - 5. Manufacturers:
 - a. Same as manufacturer of metal channel (strut) framing system.
 - b. DeWalt "Bang-It" concrete inserts.
- D. Post-Installed Concrete and Masonry Expansion Anchors:
 - 1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 - 2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.

- E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.
 - 1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 - 1. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- F. Vibration Isolation Anchors: Reference Section "Vibration Isolation for HVAC" for vibration isolation anchors.

2.06 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Malleable Iron: ASTM A47
- C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- I. Provide vibration isolators at hangers and supports where specified in Section "Vibration Isolation for HVAC".

3.03 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.
- B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- C. Space attachments within maximum piping span length specified in Division 23 piping sections.
- D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

- F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.
- G. Hanger and clamps sizing:
 - 1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
 - 2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
 - 3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
 - 4. Refer to Section "HVAC Insulation" for definition of hot and cold piping and required insulation thickness.
- H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 23 piping sections.
 - 1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
 - 2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
 - a. Uninsulated Copper Pipe: Install with plastic galvanic isolators.
 - b. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Section "HVAC Insulation".
- I. Install building attachments within concrete or to structural steel.
 - 1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.
 - 2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.
- K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
 - 1. Riser Clamps: Attach riser clamp to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 23 Section "HVAC Insulation".
 - a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert.
 - 2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

- a. If insulation protection shields are used instead of protection saddles on hot piping where vapor barrier is not required, provide high density insulation insert sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation".
3. Insulation Protection Shield: Install insulation protection shield with high density insulation insert, sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation". Do not use polymer-based shields for hot piping.
 - a. Exception for 2 inch and smaller horizontal piping with cellular glass, flexible elastomeric, or polyisocyanurate insulation: High density insulation insert is not required. Provide insulation protection shield over the insulation with length specified for pipe size and insulation thickness to prevent puncture or other damage.
4. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.
5. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
- O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
 1. Uninsulated Copper Pipe: Install with plastic galvanic isolators.
 2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section "HVAC Insulation".

3.04 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.05 EQUIPMENT SUPPORT AND ATTACHMENT

- A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
- B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.
- C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
- D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
 1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.
- F. Secure fasteners according to manufacturer's recommended torque settings.
- G. Remove temporary supports.

- H. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.
- I. Grouting: Place grout under supports for piping and equipment.

3.06 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.07 FIELD QUALITY CONTROL

- A. Examine support and attachment components for damage and defects.
- B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.
- F. Correct deficiencies and replace damaged or defective support and attachment components.

3.08 PIPE HANGER AND SUPPORT SCHEDULE

- A. Additional hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:
- C. Single Hangers:
 - 1. All pipe sizes 1-1/2 inch and less:
 - a. Band hanger.
 - b. Swivel split ring.
 - c. Clevis hanger.
- D. Trapezes and Strut-mounted Supports:
 - 1. Pipes in stationary position: Two-piece clamp, strut clamp or U-bolts.

E. Wall Supports:

1. Pipe sizes 3 inches and less:
 - a. Two-hole strap mounted to wall.
 - b. Welded steel bracket with reinforced angle or strut.

END OF SECTION 23 0529

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SECTION 23 0550
VIBRATION ISOLATION FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Vibration isolators.

1.02 COORDINATION

- A. Contractor's Responsibility:
 - 1. Verify the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.
 - 2. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.
 - 3. Coordinate selection and arrangement of vibration isolation components with the actual equipment to be installed.
 - 4. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 5. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 6. Sequencing:
 - a. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.
- B. Manufacturer's Responsibility:
 - 1. Determine vibration isolation types for all equipment and systems in accordance with the local governing code.
 - 2. Calculate the static deflection requirements for all equipment and systems to provide uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select the vibration isolation systems to provide static deflection indicated on the Vibration Isolation Schedule and as specified below. Determine the mounting sizes and layout.
 - 4. Guarantee specified isolation system deflection.
 - 5. Select and size vibration isolators to not exceed the recommended loading of the isolators.
 - 6. Provide installation instructions, drawings and field supervision to ensure proper installation and performance.
 - 7. Verify that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators.

1.03 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.

1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities. Include clearly outlined procedures for installing and adjusting the isolators.
- B. Shop Drawings:
 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators on each piece of isolated equipment. Indicate equipment weights and static deflections.
- C. Vibration Isolation System Schedule: Include the following for each isolation element:
 1. Manufacturer, isolator type, model number, size.
 2. Height when uncompressed and static deflection.
 3. Spring constant.
 4. Spring outside diameter, free operating, and solid heights.
 5. Details of attachment to load-bearing structure or supplementary framing.
- D. Post-Installation Inspection Report:
 1. Vibration isolation vendor notice of inspection of all vibration isolators.
 2. Vibration isolation vendor notice of approval that all vibration isolators have been properly installed and conform to the specification.
 3. Itemized list of deficiencies.
 4. Vibration Isolation System Schedule.
 5. For each isolator containing steel springs, record the following:
 - a. Size.
 - b. Uncompressed height.
 - c. Design static deflection.
 - d. Measured static deflection.

1.04 QUALITY ASSURANCE

- A. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.
- B. All vibration isolation equipment and materials shall be new and manufactured specifically for the purpose intended.
- C. Maintain at the project site a copy of each reference document that prescribes execution requirements.
- D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

- A. BRD Noise and Vibration Control.
- B. Caldyn, California Dynamics Corp.
- C. Kinetics Noise Control.
- D. Mason Industries, Inc.
- E. Vibration Eliminator Co., Inc.

- F. Vibration Mounting and Controls.
- G. Vibro-Acoustics.

2.02 VIBRATION ISOLATION REQUIREMENTS

- A. Construct vibration isolators out of resilient materials resistant to oil, ozone, and oxidant.
- B. Select vibration isolators to provide the static deflection as specified in Part 2 "Products" unless otherwise specified for the application listed in Part 3 "Execution."
- C. Where a pipe run connects multiple equipment, select the pipe isolators for the entire run to suit the connected equipment of greatest static deflection.
- D. Vibration isolators shall have either known undeflected heights or calibration markings so that the amount of deflection can be verified after adjustment to determine that the load is within the proper range of the device and that the correct degree of vibration isolation is provided according to the design.
- E. Vibration isolators, base frames, and inertia bases shall provide uniform deflection and stability under all operating loads.
- F. Isolators for fans shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.
- G. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.
- H. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than plus/minus 10 percent.
- I. All elastomeric mountings shall have a Shore hardness of 30 to 60 plus/minus 5 after minimum aging of 20 days or corresponding over-aging, or as specified herein.
- J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated of natural rubber instead of neoprene.
- K. Vibration Isolator Assemblies with Steel Springs:
 - 1. Housed or caged spring isolators are not acceptable.
 - 2. Assemblies shall use bare springs, color coded or otherwise identify springs to indicate load capacity.
 - 3. Spring diameter shall not be less than 0.8 of the loaded operating height of the spring.
 - 4. The ratio of the horizontal to vertical spring constant shall be between 1 and 2.
 - 5. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
 - 6. Assembly shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation.
 - 7. Springs shall operate in the linear portion of their load versus deflection curve over a deflection range of not less than 50 percent above the design deflection.
- L. Vibration isolators exposed to weather and other corrosive environments shall be protected with factory corrosion resistance.
 - 1. Interior applications: Painted.

2.03 VIBRATION ISOLATORS

- A. Double Deflecting Neoprene Mounts (Type DDNM):
 - 1. Assembly: Laterally stable, double deflecting, neoprene encapsulated mount with bolt holes for attachment to supporting structure.

2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.
3. Type DDNM: Mason Industries Type ND or approved equal.
- B. Restrained Neoprene Mounts (Type RNM)
 1. Assembly: Restrained neoprene mounting element encapsulated in a metal housing to prevent bulging of the neoprene element with bolt holes for attachment to supporting structure. Assembly shall be designed to provide isolation in tension, shear or compression.
 2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.25 inches.
 3. Type RNM: Mason Industries Type RBA or approved equal.
- C. Neoprene Bushing (Type NR):
 1. Assembly: Neoprene restraint, rubber-in-shear bushings for lightweight, suspended equipment supported from structure with all-thread rod and angle iron or Unistrut.
 2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.15 inches.
 3. Type NR: Mason Industries Type HMIB or approved equal.
- D. Spring and Neoprene Hanger (Type SPNH)
 1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator in series with a steel spring.
 - a. Housing: Include a neoprene bushing to prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function. Bottom opening sized to allow hanger rod to swing through a 30 degree arc.
 2. Selection:
 - a. Neoprene isolator: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.
 - b. Spring isolator: Minimum static deflection of 2 inches unless specified otherwise.
 3. Type SPNH: Mason Industries Type 30N or approved equal.
- E. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.
- F. Flexible Connectors:
 1. Duct: Refer to Section "Air Duct Accessories."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to receive vibration isolation and associated attachments.

3.02 INSTALLATION - GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Mount or suspend all equipment, piping, ductwork, etc. from approved foundations and supports as specified herein or as shown on the drawings.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Support piping, ductwork, conduit, and mechanical equipment from the building structure. Do not support from other equipment, piping, or ductwork.
- E. Install isolators to prevent short-circuiting of the isolation.

- F. All wiring connections to mechanical equipment on isolators shall have a minimum 18 inch long flexible conduit in a "U" shaped loop. Coordinate with Division 26.
- G. Flexible Connectors: Install flexible connectors sized to match equipment connections and to provide sufficient slack for vibration isolation as required.
- H. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Block-up equipment with temporary shims to final operating height. When the system is assembled full load is applied, adjust the isolators shall be adjusted to allow shim removal.
- I. Refer to Division 23 Section "Seismic Controls for Mechanical" for seismic bracing requirements.
- J. Refer to Division 23 Section "Common Work Results for HVAC" for noise critical spaces.

3.03 INSTALLATION OF VIBRATION ISOLATORS

- A. Neoprene Mounting Sleeves, Grommets, and Bushings: Install on vibration isolators to prevent any metal to metal contact.
- B. Spring Isolators:
 - 1. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
 - 2. Install springs so that the ends of springs remain parallel and all springs are installed with adjustment bolts.
 - 3. Locate isolation hangers at the top of hanger rods.
 - 4. Type SPNM: Unless otherwise specified, isolators need not be bolted to the floor for indoor installations.
 - 5. Type SPNH and DDNH: Install the hanger box to allow it to rotate a full 360 degrees without encountering any obstruction.
- C. Isolating Pipe Anchors:
 - 1. Weld anchor base to support steel or bolt base plate to structure. Weld or bolt pipe clamp or bracket to anchor.

3.04 EQUIPMENT ISOLATION

- A. General: External spring isolators are not required if unit is provided with internal spring isolation unless specified otherwise on the drawings. If external spring isolators are provided, internal spring isolation shall be locked in place.
- B. Blower Coil Units:
 - 1. Suspended: Type SPNH isolation with 2 inch static deflection.
- C. Fan Coil Units:
 - 1. Suspended: Flexible duct connectors with Type SPNH with 1 inch static deflection.
- D. Fans
 - 1. Suspended:
 - a. Fans 1 hp and less: Type NR isolation with 0.15 inch static deflection.
- E. All other equipment not specifically identified in this specification that contains rotating or vibrating elements and any associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM or RNM neoprene isolators as appropriate.

3.05 PIPING ISOLATION

- A. Provide isolation supports on the following HVAC pipe:
 - 1. Piping within 20 feet of the following suspended equipment: Provide Type SPNH isolators. The first isolator both upstream and downstream of equipment on springs shall have a static

deflection equal to that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 0.75 inch.

- a. Pipes connected without flexible connectors to suspended equipment that is installed with spring vibration isolators.
- B. Provide resilient diagonal mountings or other approved devices as required to limit piping motion due to equipment startup or shut down to a maximum of 1/8 inch.
- C. Where supplementary steel is required to support pipes, size the supplementary steel so that maximum deflection between supports does not exceed 0.08 inches. Isolate the supplementary steel from building structure using the same isolator required for the pipe. Rigidly suspend or support the pipe from the supplementary steel.

3.06 DUCT ISOLATION

- A. Connect ducts to equipment, fans, fan casings, and fan plenums with flexible connectors.

3.07 FIELD QUALITY CONTROL

- A. Arrange for inspection of all isolation and noise control equipment by the vibration isolation vendor and submit post-installation inspection report.
- B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.
- C. Guarantee: If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

END OF SECTION 23 0550

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Pipe markers.
- E. Engraved plastic-laminate signs.

1.02 SUBMITTALS

- A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Product Data: Submit manufacturer's technical product data for each product required.
- C. Manufacturer's Installation Instructions: Indicate special procedures and installation for each product required.

1.03 SPARE PARTS

- A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. Advanced Graphic Engraving, LLC.
- B. Brady Corporation.
- C. Brimar Industries, Inc.
- D. Craftmark.
- E. Industrial Safety Supply Co., Inc.
- F. Kolbi Pipe Marker Co.
- G. MIFAB, Inc.
- H. Seton Identification Products, a Tricor Direct Company..

2.02 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

- A. General:
 - 1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.
 - 2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.

3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).
- B. Ductwork: Adhesive-backed duct markers.
- C. Fans: Nameplates or engraved plastic laminate signs.
- D. Instrumentation: Tags.
- E. Piping: Pipe Markers.
- F. Relays: Tags.
- G. Small-sized Equipment: Tags.
- H. Thermostats: Nameplates.
- I. General Signs: Engraved plastic laminate signs.

2.03 NAMEPLATES

- A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 1. Name and mark number.
 2. Equipment service.
 3. Design capacity.
 4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
- B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.
- C. Letter Color: White.
- D. Letter Height: 1/4 inch.
- E. Background Color:
 1. Cooling equipment: Green.
- F. Plastic: Conform to ASTM D709.

2.04 TAGS

- A. Plastic Laminate Tags: Laminated three-layer plastic, minimum 3/32 inch thick, with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.
- B. Solid Plastic Tags: Solid plastic, minimum 3/32 inch thick, with printed black letters on white color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.
- C. Metal Tags: Provide 19-gauge polished brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with black enamel paint.
- D. Accident Prevention Tags: Pre-printed or partially pre-printed, of plasticized card stock with matte finish suitable for writing, minimum 3-1/4 inch x 5-5/8 inch size, with brass grommet in hole for fastener. Order with appropriate pre-printed wording (e.g., DANGER, CAUTION, DO NOT OPERATE, etc.).
- E. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the size required for proper attachment of tags to valves, manufactured specifically for that purpose.
- F. Letter Height:
 1. System Abbreviation: Minimum 1/4 inch.
 2. Valve Number: Minimum 1/2 inch.

2.05 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

- B. Style: Individual label.
- C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.
- D. Color: Yellow background with black lettering or blue background with white lettering.

2.06 PIPE MARKERS

- A. Semi-rigid Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum 3 mil thick.
 - 1. Width: 1-1/2 inch for pipes less than 6 inches (including insulation), 2-1/2 inch for pipes 6 inches and larger (including insulation).
- C. Pipe Marker with Insulation: 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Insulation shall extend 2 inches beyond each end of plastic pipe marker.
- D. Nomenclature: Manufacturer's standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as selected by the Engineer.
- E. Arrows: Provide pipe markers with integral arrows indicating direction of flow or as a separate unit of plastic.
- F. Color:
 - 1. Conform to .
 - 2. Heating, Cooling: Green with white letters.
- G. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

2.07 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Engraving stock melamine plastic laminate, engraved with manufacturer's standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:
 - 1. Name and mark number.
 - 2. Equipment service.
 - 3. Design capacity.
- E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.02 GENERAL INSTALLATION

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Install products in accordance with manufacturer's instructions.
- C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- D. Install tags on piping 3/4 inch diameter and smaller.
- E. Install in clear view and align with axis of piping.
- F. Identify service, flow direction, and pressure.

3.03 PIPING IDENTIFICATION

- A. General: Install identification on the most obviously visible portion of the pipe from the point of access.
- B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- C. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe during back-filling/top-soiling of each underground piping system. Where multiple pipes are buried in common trench and do not exceed overall width of 16 inches, install single pipe marker. For tile fields and similar artificial field installations, mark only edge pipe lines of field.
- D. Pipes less than 6 inches diameter (including insulation):, Provide full-band pipe markers with 360 degree coverage.
- E. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:
 - 1. Within 5 feet of each valve, tee, and control device.
 - 2. Within 5 feet of each branch, excluding branches less than 25 feet in length to fixtures or terminal heating and cooling units.
 - 3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
 - 4. At access doors, manholes and similar access points which permit view of concealed piping.
 - 5. Within 5 feet of equipment outlets and other points of origination and termination.
 - 6. Spaced intermediately at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.

3.04 DUCTWORK IDENTIFICATION

- A. Install identification on the most obviously visible portion of the duct from the point of access.
- B. Location: Install ductwork identification where ductwork is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.), and exterior non-concealed locations as follows:
 - 1. Within 5 feet of each control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.
 - 2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.
 - 3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.

4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.
5. Within 5 feet of equipment outlets and other points of origin or termination.
6. Install marker on the most obviously visible portion of the duct from point of access.

3.05 ACCESS DOOR IDENTIFICATION

- A. Provide identification on each access door, indicating purpose of access, maintenance and operating instructions, and appropriate safety and procedural information.
- B. Where access doors are concealed above a removeable ceiling system or similar concealment, tags may be used in lieu of specified identification.

3.06 EQUIPMENT IDENTIFICATION

- A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:
 1. To distinguish between multiple units in close proximity.
 2. To inform operator of operational requirements.
 3. To indicate safety and emergency precautions.
 4. To warn of hazards and improper operations.
- B. Adjust lettering size based on viewing distance from normal location of identification:
 1. Less than 2 feet: Minimum 1/4 inch.
 2. Up to 6 feet: Minimum 1/2 inch.
 3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.
 4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
 5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.
- C. Where equipment to be identified is concealed above acoustical ceilings or similar removeable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

END OF SECTION 23 0553

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SECTION 23 0593
TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. General testing, adjustment, and balancing requirements.
- B. Pre-testing, adjustment, and balancing of existing air systems.
- C. Pre-testing, adjustment, and balancing of existing hydronic systems.
- D. Testing, adjustment, and balancing of air systems.
- E. Testing, adjustment, and balancing of hydronic systems.
- F. Sound and vibration measurement of equipment operating conditions.
- G. This section excludes:
 - 1. Testing boilers and pressure vessels for compliance with safety codes;
 - 2. Specifications for materials for patching mechanical systems;
 - 3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
 - 4. Requirements and procedures for piping and ductwork systems leakage tests.

1.02 DEFINITIONS

- A. TAB: Testing, adjusting, and balancing.
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report forms: Data sheets arranged for collecting test data in logical order for submission and review. Data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. Examples include inlets and outlets on water terminals, inlets and outlets from air terminal units, and inlets and outlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- H. Main: Duct or pipe containing the major or entire fluid flow of the system.
- I. Submain: Duct or pipe containing part of the system capacity and serving two or more branch mains.
- J. Branch main: Duct or pipe serving two or more terminals.
- K. Branch: Duct or pipe serving a single terminal.

1.03 SUBMITTALS

- A. Qualifications:
 - 1. Submit qualifications of TAB agency.
 - 2. Submit qualifications of TAB supervisor.

- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
- C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Preconstruction Test Report:
 - 1. Submit preconstruction test report of existing systems as indicated on the drawings. Submit report prior to start of construction on the affected systems for review and comment by the engineer. Reference Part 3 for test procedures.
 - 2. Report format shall follow Draft Report procedures specified above.
 - 3. Report shall include all information requested by the procedures for each system covered by the scope of work. Information omitted or missed during the initial or subsequent pretests shall be documented via additional site visits at no additional cost to the owner.
- F. Progress Reports.
- G. Certified TAB Reports:
 - 1. General:
 - a. Submit within two weeks after completion of testing, adjusting, and balancing.
 - b. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - c. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 2. Draft Report: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
 - 3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:
 - a. The systems have been tested, adjusted, and balanced in accordance with the referenced standards.
 - b. The report reflects an accurate representation of how the systems have been installed.
 - c. The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.
 - d. The report is an accurate record of all final quantities measured to establish normal operating values of the systems.
 - 4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, and cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:
 - a. General Information and Summary
 - 1) Include project name, location, altitude, and date.
 - 2) Identify TAB agency, contractor, owner, architect, and engineer.
 - 3) Include addresses, contact names, and telephone numbers.
 - 4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.

- 5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - b. Air Systems
 - c. Hydronic Systems
 - d. Temperature Control Systems
 - e. Sound and Vibration Systems
- 5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE 111.
- 6. Units of Measure: Report data in I-P (inch-pound) units only.
- H. Project Record Documents: Provide drawings that record actual locations of flow measuring stations and balancing devices.

1.04 QUALITY ASSURANCE

- A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
- B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter "Testing, Adjusting, and Balancing", most current edition.
- C. TAB Agency Qualifications:
 - 1. Act as the single source of responsibility for TAB of the HVAC systems.
 - 2. Staff the project at all times by qualified personnel.
 - 3. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.
 - 4. Certified by one of the following Certification Associations:
 - a. AABC (NSTSB): Associated Air Balance Council, National Standards for Total System Balance.
 - b. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 - c. TABB: Testing, Adjusting, and Balancing Bureau, SMACNA TAB Procedural Guide.
- D. TAB Supervisor and Technician Qualifications:
 - 1. Certified by the same organization as TAB agency.
 - 2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.

PART 2 - PRODUCTS AND MATERIALS – NOT USED

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.
- B. Test, adjust, and balance the air systems before hydronic systems.
- C. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.

- D. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- E. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.
- F. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.
- G. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- H. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Motors and bearings are lubricated.
 - 5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 6. Duct systems are clean of debris.
 - 7. Fans are rotating correctly and belts have tension.
 - 8. Fire, smoke, fire/smoke, and volume dampers are in place and open.
 - 9. Air coil fins are cleaned and combed.
 - 10. Volume dampers are installed at locations needed for balancing the air systems.
 - 11. Access doors are closed and duct end caps are in place.
 - 12. Air outlets are installed and connected.
 - 13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.
 - 14. Hydronic systems are flushed, filled, and vented.
 - 15. Hydronic systems are tested for leaks.
 - 16. Test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves are properly installed and that their location is accessible.
 - 17. Proper strainer baskets are clean and in place.
 - 18. Service and balance valves are open.
 - 19. Air vents are operating freely.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

- A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.
- B. Furnish all instruments required for testing, adjusting, and balancing operations.

1. Verify all instruments have been calibrated.
 2. Furnish instruments as recommended by the manufacturer for the TAB application.
 3. Furnish instruments that are best suited to the function being measured.
 4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.
- D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.
- E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- F. Determine best locations in main and branch ductwork for most accurate duct traverses.
- G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.
- B. Air Outlets and Inlets: Balance branch ducts and terminal devices to within plus or minus 10 percent of design airflow.
- C. Hydronic Systems: Balance to within plus or minus 5 percent of design flow.

3.05 RECORDING AND ADJUSTING

- A. Record data regarding design conditions from contract documents and installed conditions from shop drawings including equipment identification number, model number, location, area served, manufacturer, model number, serial number, motor nameplate horsepower and rpm, fan rpm, capacity and electrical voltage, amps and phases.
- B. For all systems measure and record the ambient conditions at the time of testing and balancing. Include the following:
1. Dry bulb temperature.
 2. Relative humidity.
 3. Cloud cover.
 4. Wind speed.
 5. Time.
- C. Field Logs: Maintain written logs including:
1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- D. Ensure recorded data represents actual measured or observed conditions.
- E. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- F. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

- H. Cut insulation around ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- I. Patch and seal insulation, vapor barrier, ductwork, and housings, using materials identical to those removed.
- J. Seal ducts and piping and test and repair leaks.
- K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- L. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- M. Check and adjust systems approximately six months after final acceptance and submit report.
- N. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive values are obtained.
- O. Take all readings at eye level of the indicated value to prevent parallax.
- P. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- Q. Take measurements in the system where best suited for the task.
- R. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.06 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING AIR SYSTEMS

- A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.
- B. TAB Contractor:
 - 1. Measure and record the operating speed, airflow, and total and external static pressure of each fan system. Provide individual pressure drop readings across all coils, filter banks, dampers and other internal fan system components
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the condition of filters.
 - 4. Check the condition of coils.
 - 5. Check the operation of the drain pan and condensate-drain trap.
 - 6. Check bearings and other lubricated parts for proper lubrication.
 - 7. Report on the results of the measurements taken and any deficiencies.
- C. Mechanical Contractor:
 - 1. Report on the operating condition of the equipment and any deficiencies.

3.07 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING HYDRONIC SYSTEMS

- A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.
- B. TAB Contractor:
 - 1. Open automatic control valves to full design position to simulate a design day. Close coil bypass valves.
 - 2. Examine HVAC system and equipment installations to verify that existing balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices and balancing valves and fittings are properly installed. Verify that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

3. Remove, clean, and reinsert all strainers.
 4. Check air vents at high points of systems and determine if all are operating freely (automatic type) or to bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Measure and record the hydronic flow and pressure drop of each piece of HVAC equipment.
 7. Measure motor voltage and amperage. Compare the values to motor nameplate information.
- C. Mechanical Contractor:
1. Install additional instrumentation and test ports as requested by the testing, adjusting, and balancing contractor to obtain the necessary measurements of the existing system.

3.08 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Check filters for cleanliness.
- B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
- C. Verify volume dampers are installed at locations needed for balancing the air systems.
- D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- E. Determine best locations in main and branch ductwork for most accurate duct traverses.
- F. Place outlet dampers in the full open position.
- G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
- H. Lubricate all motors and bearings.
- I. Check fan belt tension.
- J. Check fan rotation.
- K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.
- L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- M. Measure air quantities at air inlets and outlets.
- N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- O. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices such as dampers and splitters.
- P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- R. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- T. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:

1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.
2. Operate supply fan at design speed and measure the outdoor airflow.
3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.
4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.
5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.
6. Repeat this procedure to determine damper position for absolute minimum ventilation.

3.09 HYDRONIC SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Open valves to full open position. Close coil bypass valves.
- B. Remove and clean all strainers.
- C. Clean and set automatic fill valves for required system pressure.
- D. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
- E. Set temperature controls so all coils are calling for full flow.
- F. Check and set operating temperatures of chillers to design requirements.
- G. Lubricate all motors and bearings.
- H. Adjust water systems to provide required or design quantities.
- I. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on correlated flow from temperature and pressure gauges across the heat transfer elements in the system.
- J. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- K. Affect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- L. Record the necessary information for optimizing pump operation as defined on the controls drawings. Give this information to the controls contractor for building automation system programming.

3.10 TESTING FOR SOUND AND VIBRATION

- A. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards:
 1. ASHRAE: ASHRAE Handbook, HVAC Applications Volume, Chapter "Sound and Vibration Control", most current edition.
 2. NEBB: "Procedural Standards for the Measurement and Assessment of Sound and Vibration."
- B. Other than sound data, failure of an item includes a deviation of more than 10 percent from setpoint. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
 1. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

- C. Prepare and submit report of recommendations for correcting any sound or vibration levels that are outside of manufacturer's tolerances, ASHRAE standards and/or values specified in the contract documents.

END OF SECTION 23 0593

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**SECTION 23 0700
HVAC INSULATION**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Piping Insulation.
- B. External Ductwork Insulation.

1.02 RELATED REQUIREMENTS

- A. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, pipe saddles, and high-density insulation inserts.
- B. Division 23 Section "Metal Ducts" for duct liner insulation.

1.03 DEFINITIONS

- A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.
- B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.
- C. Neutral Ductwork: Ductwork that carries airflow with temperatures between the defined cold and hot temperatures.
- D. Exposed: Insulation that is visible from the occupied space.
- E. Unconditioned Spaces: An enclosed space within a building that is not provided with mechanical heating or cooling.

1.04 SUBMITTALS

- A. Product Data: Submit technical product data, thermal characteristics, and materials for each type of mechanical insulation.
- B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.01 PIPING INSULATION MATERIALS

- A. Mineral Fiber (rock, slag, or glass):
 - 1. Manufacturers:
 - a. Johns Manville.
 - b. Knauf Insulation.
 - c. Owens Corning.
 - 2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.
 - a. K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.
 - b. Minimum Service Temperature: 0 degrees F
 - c. Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.
 - d. Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.
 - 3. Factory Applied Jacket: ASTM C1136, Type I.
 - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.
 - b. Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.
 - c. Color: White.
- B. Flexible Elastomeric:
 - 1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.
 - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 297 degrees F
 - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
 - 3. Factory Applied Jacket:
 - a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Piping Jacket Schedule in Part 3 of this specification for application of this jacket.
- C. Field-Applied Jacket:
 - 1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

2. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
 - a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
 - b. Manufacturers:
 - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
 - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
 - 3) Or approved equal.
3. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in)		
	Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco
≤ 36	0.032	0.020	See Note 1
> 36	0.040	0.024	See Note 1

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

- a. Banding:
 - 1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
 - 2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.
4. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
5. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulated duct and piping applications. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 15 pounds per ASTM D1000.
- D. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
 1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
 2. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
 3. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02
Ducts (40 F to ambient)	1.0	0.03

Notes:

4. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
5. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.
- F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

2.02 EXTERNAL DUCTWORK INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
2. Insulation: ASTM C553, Type I or II, flexible mineral fiber blanket.
 - a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 20 degrees F
 - c. Maximum Service Temperature: 450 degrees.
 - d. Density:
 - 1) 1.5 pounds per cubic foot.
3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
 - a. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch stapling tab.
 - b. Polypropylene Scrim Kraft (PSK): Kraft paper with glass fiber yarn and bonded to metalized polypropylene, water vapor permeance of 0.02 perms and 2 inch stapling tab.
 - c. Color: White

B. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:
 - a. Johns Manville.
 - b. Knauf Insulation.
 - c. Owens Corning.
2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.
 - a. K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.
 - b. Minimum Service Temperature: 0 degrees F
 - c. Maximum Service Temperature: 450 degrees.

- d. Density:
 - 1) 1.5 pounds per cubic foot.
- 3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
 - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
 - b. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.
 - c. Polypropylene Scrim Polyester (PSP): Polyester paper with glass fiber yarn and bonded to polypropylene, water vapor permeance of 0.02 perms.
 - d. Color: White.
- C. Field-Applied Jacket:
 - 1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
 - 2. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.
 - a. Thickness: 0.032 inch sheet.
 - b. Finish: Smooth or Stucco. Reference Part 3 for jacket applications.
 - c. Joining: Longitudinal slip joints and 2 inch laps.
 - d. Fittings: 0.032 inch thick die shaped fitting covers with factory attached protective liner.
 - e. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
 - 3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
 - 4. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulation. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.
- D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and other appurtenances as recommended by insulation manufacturer for applications indicated.
- E. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coatings, sealers, mastics, protective finishes, and similar compounds as recommended by insulation manufacturer for applications indicated.
 - 1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.
 - 2. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber-based adhesive.
 - 3. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Fosters 30-80, Childers CP-38, Design Polymerics 3040, or equal.
 - 4. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
 - 5. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 PROTECTION AND REPLACEMENT

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.
- B. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.
- C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.03 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

3.04 PIPING SYSTEM INSULATION INSTALLATION

- A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Exposed Piping: Locate insulation and cover seams in least visible locations.
- E. Cold Pipe Insulation:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Provide vapor barrier jacket according to the Piping Jacket Schedule.
 - 3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
 - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 - 5. Secure all-service jacket with self-sealing longitudinal laps.
 - 6. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

F. Hot Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide jackets without vapor barrier according to the Piping Jacket Schedule. Jackets with vapor barrier are allowed.
3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Secure all-service jacket with self-sealing longitudinal laps.
6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation of Fittings, Valves, Strainers, Flanges, and Unions:

1. Insulate fittings, joints, and valves with molded insulation of like material, vapor barrier coating, and thickness as adjacent pipe. Provide pre-formed insulation pieces, segmented insulation, or sectional pipe insulation for the application. Provide the same insulation jacket as adjoining pipe.
2. Sectional pipe insulation: Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Hold sectional cuts in place with tie wire or bands. Wire and bands shall be compatible with insulation and jacket.
3. Segmented pipe insulation: Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.
4. Butt each insulation piece tightly against adjoining piece of insulation. Bond pieces together according to Cold Pipe or Hot Pipe installation instructions.
5. Insulate valves up to and including the bonnets, valve stuffing-box studs, bolts, and nuts with a removeable insulation cover. Sectional valve insulation covers shall divide the section along the vertical center line of the valve body.
6. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover.
7. Insulate flanges and unions with a removeable insulation cover. Sectional pipe insulation covers shall divide the section along the center line of pipe.
8. When removeable covers are made from sectional block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, around the insulated device with tie wire. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
9. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. PVC fitting covers with end caps are also acceptable. Tape PVC covers to adjoining insulation facing using PVC tape.
10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape

insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Maintain vapor barrier through the penetration.

3.05 PIPING SYSTEM INSULATION SCHEDULE

- A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.
- B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.
- C. Omit insulation on the following:
 1. Hot piping within radiation enclosures or unit cabinets.
 2. Cold piping within unit cabinets provided piping is located over drain pan.
 3. Heating piping between coil and shutoff valves provided piping is located within heated space and not more than three feet from coil.
 4. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.
- D. Cold Piping (40 degrees F (4.4 degrees C) to 60 degrees F):
 1. Service:
 - a. Chilled water supply and return piping.
 - b. Air conditioner condensate drain piping.
 2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
 - a. Mineral fiber.
 - b. Flexible elastomeric.
- E. Warm Temperature Piping (105 degrees to 140 degrees F (40 to 94 degrees C)):
 1. Service:
 - a. Heating hot water supply and return piping.
 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Mineral fiber.
 - b. Flexible elastomeric.
- F. Hot Non-Steam Piping (141 to 200 degrees F (61 to 94 degrees C)):
 1. Service:
 - a. Heating hot water supply and return piping.
 2. Acceptable Insulation:
 - a. Mineral fiber.
 - b. Flexible elastomeric .

3.06 PIPE INSULATION THICKNESS SCHEDULE

A. IECC –2018 Requirements, Pipe Insulation

Fluid Operating Temp. Range (°F) And Usage	Minimum Pipe Insulation Thickness		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	Insulation Thickness, in.				
			<1	1 to 1-1/2	1-1/2 to <4	4 to 8	≥8
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0

Notes:

- For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
- For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} - 1]$ where
 - T = minimum insulation thickness (in.),
 - r = actual outside radius of pipe (in.),
 - t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
 - K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and
 - k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
- The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.07 PIPING JACKET SCHEDULE

- Exposed piping within mechanical rooms (above 10 feet):
 - Canvas.
 - Semi-rigid PVC.
 - Rigid aluminum shell.
- Exposed piping:
 - All-service jacket.
 - Canvas.
 - Semi-rigid PVC.
- Piping within return air plenums:
 - All-service jacket.
 - Canvas.

3.08 DUCTWORK INSULATION SYSTEM INSTALLATION

- Maintain continuous thermal and vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.

- B. Install insulation on duct systems subsequent to painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces.
- D. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Install insulation without sag on underside of duct. Where rectangular ducts are 24 inches in width or greater, secure external insulation to the bottom of the duct with mechanical fasteners, spaced on 18 inches on center (maximum). Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Secure insulation to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention. Lift duct off trapeze hangers and insert spacers to avoid insulation compression.
- F. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- G. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.
- H. Lined Ductwork: At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.
- I. Hot and Neutral Ducts:
 - 1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
 - 2. Provide jackets with or without vapor barrier according to the Ductwork Jacket Schedule.
 - 3. Secure joints with staples, tape, or wires.
 - 4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

3.09 DUCTWORK SYSTEM INSULATION SCHEDULE

- A. Omit insulation on the following:
 - 1. Lined ductwork that is interior to the building unless otherwise indicated on the drawings.
 - 2. Interior ductwork with sound absorbing linings unless otherwise indicated on the drawings.
- B. Prohibited insulation:
 - 1. Polyisocyanurate installed within a return air plenum.
- C. Supply Air:
 - 1. Service:
 - a. Supply ducts from air handling equipment.
 - 2. Acceptable Insulation:
 - a. Flexible mineral fiber.
 - b. Rigid mineral fiber.
 - c. Flexible elastomeric.
- D. Return Air:
 - 1. Service:
 - a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
 - b. Interior ductwork routed through or from unconditioned spaces and plenums.

2. Acceptable Insulation:
 - a. Flexible mineral fiber.
 - b. Rigid mineral fiber.
 - c. Flexible elastomeric.
- E. Exhaust Air.
 1. Service:
 - a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
 2. Acceptable Insulation:
 - a. Flexible mineral fiber.
 - b. Rigid mineral fiber.
 - c. Flexible elastomeric.

3.10 DUCT SYSTEM INSULATION THICKNESS SCHEDULE

- A. Flexible Mineral Fiber:
 1. Interior Ductwork:
 - a. 1.5 pounds per cubic foot density:
 - 1) 2 inch thick, minimum R-6.0.
 2. Meet R-value installed at maximum 25% compression, application limited to concealed locations.
- B. Rigid Mineral Fiber:
 1. Interior Ductwork:
 - a. 1.5 pounds per cubic foot density:
 - 1) 1-1/2 inch thick, minimum R-6.0.
- C. Flexible Elastomeric:
 1. Interior Ductwork:
 - a. 1-1/2 inch thick, minimum R-6.0.

3.11 DUCTWORK JACKET SCHEDULE

- A. Omit jacket on internally lined ductwork.
- B. Exposed ductwork within mechanical rooms (above 10 feet):
 1. Foil Scrim Kraft (FSK).
 2. Polypropylene Scrim Kraft (PSK).
 3. All-Service Jacket (ASJ).
 4. Polypropylene Scrim Polyester (PSP).
 5. Flexible Metal Cladding (flexible elastomeric only).
- C. Ductwork within return air plenums:
 1. Foil Scrim Kraft (FSK).
 2. Polypropylene Scrim Kraft (PSK).
 3. All-Service Jacket (ASJ).
 4. Polypropylene Scrim Polyester (PSP).
 5. Flexible Metal Cladding (flexible elastomeric only).

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SECTION 23 0913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Control valves.
- B. Control dampers.
- C. Operators.
- D. Input/Output sensors and transmitters.
- E. Output control devices.
- F. Power Supplies.
- G. Thermostats.

1.02 DEFINITIONS

- A. BAS: Building Automation System.
- B. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations.
- C. Cv: Design Valve Flow Coefficient.
- D. DDC: Direct Digital Control.
- E. EPDM: Ethylene Propylene Diene Monomer.
- F. High voltage: 50 volts or higher.
- G. Low voltage: Below 50 volts.
- H. PTFE: Polytetrafluoroethylene.
- I. TEFZEL: A modified ETFE (ethylene tetrafluoroethylene) fluoroplastic.

1.03 CONTRACTOR RESPONSIBILITIES

- A. Reference Division 23 Section "Electrical Coordination for Mechanical Equipment" for contractor responsibilities.
- B. BAS Contractor:
 - 1. Installation of the BAS shall be by the BAS Contractor or their subcontractors.
 - 2. Low voltage control wiring.
 - 3. Coordinate high voltage control wiring to instrumentation and control devices with Division 26. Where high voltage power is required for instrumentation and control devices that is in addition to what is shown on the drawings, the BAS contractor shall cover the cost of providing this wiring.
 - 4. All interlock wiring regardless of voltage (e.g., exhaust fan interlocked to supply fan).
 - 5. Coordinate with Division 26 that motor starters are provided with auxiliary contacts as required for interlocks.
 - 6. Coordinate power wiring to BAS controllers and instrumentation and control devices with Division 26.

7. Coordinate installation of back-box rough-in for wall-mounted control devices sensors, etc. with Division 26. Coordinate with mechanical contractor all locations, quantities, and sizes required for installation by Division 26.
 8. Perform startup and demonstration services as specified in Section "Direct Digital Control for HVAC".
- C. Sheet Metal Contractor:
1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
 2. Access doors where and as required.
- D. Mechanical Contractor:
1. Installation of immersion wells.
 2. Installation of flow switches.
 3. Installation of automatic control valves.
 4. Installation of pressure tappings and associated shut-off cocks.
 5. Coordinate conduit and wall box rough-in, power wiring and magnetic starter requirements for controls and mechanical equipment with Division 26.

1.04 SUBMITTALS

- A. Refer to Division 01 for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include dimensions, capacities, size, performance characteristics, electrical characteristics, and finishes of materials.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Schedule for control valves and actuators, including the following:
1. Tag.
 2. Quantity.
 3. Model number.
 4. Equipment served.
 5. Flow at project design conditions.
 6. Selected valve flow coefficient (Cv). For butterfly valves, submit the corresponding valve position at which the Cv is calculated.
 7. Pressure differential drop across valve at project design flow conditions and selected Cv.
 8. Maximum close-off pressure.
 9. Valve Configuration (2-way/3-way).
 10. Valve Normal Position and Fail Position (e.g., NO/FO; normally open/fail open).
 11. Valve Size.
 12. Line Size.
 13. Valve Type.
 14. Actuator Signal Type (Open/Close, Modulating 0-10 Vdc, 2-10 Vdc, 4-20 mA, etc.)
 15. Torque required to close valve at pump shutoff head.
 16. Selected actuator maximum torque output.
- E. Manufacturer's Instructions: Provide for all manufactured components.

- F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
- G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
- H. Warranty: Submit manufacturer warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- C. Control valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI and MSS standards.
- D. Measurement devices and sensors shall be calibrated using NIST traceable standards.

1.06 WARRANTY

- A. Correct defective Work within a one year period after Substantial Completion.
- B. Existing Equipment Warranty: Contractor shall maintain and provide a standard 12 month warranty for any existing equipment, valves, actuators, devices, sensors, transmitters, and thermostats that are selected to be reused for the project. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of system startup and demonstration.
- C. Provide extended warranty for control devices and equipment as specified herein.

PART 2 - PRODUCTS

2.01 OWNER FURNISHED PRODUCTS

- A. New Products: Control devices required for the removal and reinstallation of Fan Coil unit in Broadcast Studio and new temperature sensors for heat removal fans.
- B. Existing Products: Control devices shall tie-into the building's existing DDC control network.

2.02 CONTROL VALVES

- A. General:
 - 1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Each valve shall be equipped with proper packing to ensure there will be no leakage at the valve stem.
 - 2. Pressure Ratings:
 - a. Valve body and packing rated to withstand the system static head plus the maximum pump head and the maximum temperature of the control medium (i.e. chilled water, steam, hot water, etc.).
 - 1) Minimum pressure class 150psig.
 - b. Two-way modulating valves and their operators shall have close-off pressure ratings exceeding the dead-head condition of the pump in the system it serves.
 - c. Two-way modulating valves with equal percentage flow characteristics and their operators shall be rated to safely operate within a differential pressure range between 2 and 50 psi across the valve without cavitating.

3. Sizing:
 - a. Hydronic Systems:
 - 1) Modulating: Select valves with an appropriate flow coefficient (Cv) to achieve a minimum design valve authority of 0.5 relative to the total pressure drop of the piping branch the valve controls. Calculate Cv based on the larger of the following:
 - a) 5-psig pressure drop at the design flow rate specified in the Schedules.
 - b) Twice the equipment design pressure drop as specified in the Schedules unless otherwise noted:
 - i) Minimum Flow Primary Bypass Valve: Refer to the drawings for the required flow rate and pressure drop.
 - c) Valve shall not be less than 1/2 Inch in size.
 - d) Size butterfly valves using the 60 degree of full open flow coefficient (Cv).
4. Flow Characteristics:
 - a. Hydronic Service:
 - 1) Two-way valves: Equal percentage characteristic.
5. End Connections:
 - a. Reference the Control Valve Schedule in Part 3 for allowable end connections by pipe material.
 - b. Carbon steel and stainless steel valves shall comply with ASME B16.34.
 - c. Comply with ASME B16.10 for face-to-face and end-to-end dimensions.
 - d. Threads:
 - 1) Comply with ASME B1.20.1.
 - 2) Comply with ASME B16.4 for cast iron.
 - 3) Comply with ASME B16.15 for cast copper alloys, including bronze and brass.
 - e. Flanges:
 - 1) Comply with ASME B16.5 for steel.
 - 2) Comply with ASME B16.1 for cast iron
 - 3) Comply with ASME B16.24 for cast copper alloys, including bronze and brass.
 - f. Grooved Fittings:
 - 1) Water services to 230 deg F and 250 psig.
- B. Globe Pattern:
 1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size and end connection by application.
 2. Construction:
 - a. Up to 2 inches: Class 150, ASTM B62 bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 - 1) Bronze body and bonnet shall conform to ASTM B62 up to pressure class 150. Conform to ASTM B61 for pressure class 200 and higher.
 - 2) Iron body and bonnet shall conform to ASTM A126, class B.
 - b. Bonnet:
 - 1) Bronze body, Class 150 or higher: Union type.
 - 2) Iron body: Bolted type.

- c. Disc Material:
 - 1) PTFE.
 - 2) Stainless steel.
 - d. Stem: Outside screw and yoke. Include extension for insulation.
 - e. Two-piece brass packing gland assembly, non-asbestos composition packing.
 - 3. Rangeability: Minimum 50:1.
 - 4. Leakage:
 - a. Up to 1-1/4 Inch: Minimum ANSI Class III per ANSI/FCI 70-2.
 - b. 1-1/2 Inch and Larger: Minimum ANSI Class IV per ANSI/FCI 70-2.
 - 5. Design and Testing:
 - a. MSS SP-80 for bronze.
 - b. MSS SP-85 for cast iron.
- C. Ball Pattern:
 - 1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.
 - 2. Construction:
 - a. Body:
 - 1) Bronze conforming to ASTM B61, B62, and B584.
 - 2) Forged brass with or without nickel plating conforming to ASTM B283.
 - 3) Cast carbon conforming to ASTM A216.
 - 4) Cast iron according to ASTM A126.
 - 5) Stainless steel conforming to ASTM A351.
 - b. Up to 2 inches: Two-piece construction
 - c. Stainless steel, blowout proof stem. Include extension for insulation.
 - d. Replaceable PTFE seats and EPDM O-ring or PTFE packing seals.
 - 3. Ball: Full port with characterized insert comprised of the following material:
 - a. Stainless steel.
 - b. Chrome-plated.
 - c. Nickel-plated.
 - 4. Rangeability: Minimum 50:1.
 - 5. Leakage: Minimum ANSI Class IV per ANSI/FCI 70-2.
 - 6. Design and Testing:
 - a. MSS SP-72 for flanged ends.
 - b. MSS SP-110 for threaded and grooved ends.
- D. Manufacturers:
 - 1. Belimo.
 - 2. Bray.
 - 3. Danfoss.
 - 4. Fisher Controls.
 - 5. Griswold Controls.
 - 6. Honeywell.
 - 7. Johnson Controls, Inc.

8. Kele.
 9. Schneider Electric.
 10. Siemens.
 11. Victaulic (Tour & Andersson).
- E. At the contractor's discretion, control valves and balancing valves may be combined into a single device. Submit pricing deduct as an alternate to the base bid.
1. Manufacturers:
 - a. Victaulic, TBV-TC/TCM Series.

2.03 CONTROL DAMPERS

- A. Dampers shall be factory fabricated and sized as shown on drawings and as specified.
- B. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.
- C. Performance: Test in accordance with AMCA 500-D.
1. Pressure Drop: Unless otherwise scheduled or indicated on the Drawings, size control dampers as follows:
 - a. Modulating Dampers: Provide dampers with linear flow characteristics. Size modulating dampers based on the smaller of the following.
 - 1) Maximum velocity of 1,500 feet per minute.
 - 2) Maximum Full-open air pressure drop of 0.1 inches W.C.
 - b. Two Position Dampers: Dampers shall be full duct size and selected to minimize pressure drop.
 2. Leakage:
 - a. Motorized dampers for outdoor, exhaust and relief air and for shaft and stairway vents shall be Class I leakage and shall not exceed 4.0 CFM/square foot in full closed position at 1 inch W.G. pressure differential across damper.
 - b. Motorized dampers for other applications shall be Class II leakage.
- D. Frames: Galvanized steel, extruded aluminum, or stainless steel, welded or riveted with corner reinforcement.
1. Use minimum 16 gauge for rectangular dampers.
 2. Use minimum 20 gauge for round dampers.
 3. For aluminum frames, use 1/8 inch thick material.
 4. All damper frames shall have a flange for duct mounting.
 5. Reference Part 3 Execution for application of the material type.
- E. Blades: Galvanized steel, extruded aluminum, or stainless steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.
1. Use minimum 16 gauge for rectangular dampers.
 2. Use minimum 16 gauge for round dampers.
 3. For aluminum blades, use 1/8 inch thick material.
 4. The blades shall be suitable for the air velocities to be encountered in the system.
 5. Dampers longer than the maximum blade length shall be fabricated in sections.
 6. Reference Part 3 Execution for application of the material type.
- F. Blade Seals: Synthetic elastomeric inflatable or Neoprene, mechanically attached, field replaceable.
1. Installed along the top and bottom of the frame and on all mating surfaces.

- G. Jamb Seals: Spring stainless steel.
 - 1. Installed inside the frame sides.
- H. Shaft Bearings: One of the following as recommended by manufacturer for the application:
 - 1. Oil impregnated sintered bronze.
 - 2. Graphite impregnated nylon sleeve with thrust washers at bearings.
 - 3. Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.
 - 4. Molded synthetic bearings.
- I. Linkage Bearings: One of the following as recommended by manufacturer for the application:
 - 1. Oil impregnated sintered bronze
 - 2. Graphite impregnated nylon.
- J. Maximum Pressure Differential: 6 inches wg.
- K. Temperature Limits: -40 to 200 degrees F.
- L. Manufacturers:
 - 1. Greenheck.
 - 2. CESCO.
 - 3. Pottorff.
 - 4. Nailor.
 - 5. Ruskin.
- M. Reference the Damper Schedule in Part 3 for basis of design damper model and material for the application.

2.04 OPERATORS

- A. General:
 - 1. Voltage: Voltage selection shall be as required to achieve the required torque for the application.
 - a. Reference Part 3 for Damper Operator Voltage Schedule.
 - 2. Type: Motor operated, with or without gears. Motor type shall be continuous duty.
 - 3. Construction:
 - a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
 - 4. Field Adjustment:
 - a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
 - b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
 - 5. Two-Position Actuators: Single direction, spring return or reversing type. End-switches shall be integral to the actuator to determine actuator status.
 - 6. Modulating Actuators:
 - a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
 - b. Control Input Signal:
 - 1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.

- 2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-Vdc or 2- to 10-Vdc and 4- to 20-mA signals.
 - 3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
 - c. Programmable Multi-Function:
 - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
 - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
 - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
7. Position Feedback:
 - a. Where indicated on the controls drawings, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
 - b. Where indicated on the controls drawings, equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
 - c. Actuator shall contain position indicator and graduated scale indicating open and closed travel limits.
8. Integral Overload Protection:
 - a. Provide against overload throughout the entire operating range in both directions.
 - b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
9. Attachment:
 - a. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to device without the need for connecting linkages.
 - b. Attach actuator to device drive shaft in a way that ensures maximum transfer of power and torque without slippage.
10. Temperature and Humidity:
 - a. Temperature: Suitable for operating temperature range encountered by application.
 - b. Humidity: Suitable for humidity range encountered by application, non-condensing.
11. Enclosure:
 - a. Suitable for ambient conditions encountered by application.
 - b. NEMA 4 for indoor wash-down or wet locations.
 - c. NEMA 4X, Belimo ZS-300, or equivalent; for outdoor applications.
 - d. Provide actuator enclosure with heater and control where required by application.
12. Stroke Time:
 - a. Coordinate with stroke time indicated on the control drawings.
 - b. Unless otherwise noted, select operating speed to be compatible with equipment and system operation.
- B. Damper Operators:
 1. Controls contractor shall size damper operator.

2. Sizing: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - b. Provide one operator for maximum 20 sq ft damper section or maximum 7 in-lb/sq ft damper area.
 3. Fail Positions:
 - a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection. Normal positions are indicated on the control drawings.
 - 1) Return air damper, normally open.
 - 2) Outside air damper, normally closed.
 - 3) Exhaust/Relief air damper, normally closed.
 - b. Operator shall fail in place for all other applications not listed under spring return.
- C. Valve Operators
1. Sizing: Select operator with sufficient torque capacity to operate the valve under all conditions and to guarantee tight shut-off of as specified against system pressure encountered.
 - a. Operators for Hydronic Control Valves: Capable of closing valve against system pump dead head.
 2. Fail Positions:
 - a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection.
 - 1) Pre-heat coil, normally open.
 - 2) Other devices needing fail safe operation to account for freeze protection, power failure, overheating or moisture damage, reference control drawing points list for normal position.
 - b. Operator shall fail in place for all other applications not listed under spring return.
- D. Manufacturers:
1. Damper Operators:
 - a. Belimo.
 - b. Honeywell.
 - c. Johnson Controls.
 - d. Schneider Electric (Invensys).
 - e. Siemens.
 2. Valve Operators:
 - a. Belimo.
 - b. Bray.
 - c. Danfoss.
 - d. Fisher Controls.
 - e. Honeywell.
 - f. Johnson Controls.
 - g. Schneider Electric (Invensys).
 - h. Siemens.

2.05 INPUT/OUTPUT SENSORS AND TRANSMITTERS

A. General:

1. Performance Requirements:

- a. Device must be compatible with project DDC controllers.
- b. Elements used shall be general-purpose type.
- c. Provide transmitters or transducers with sensors as required, with range suitable for the system encountered.
 - 1) Transmitters and transducers shall have offset and span adjustments.
 - 2) Shock and vibration shall not harm the transmitter or transducer.
 - 3) Transmitters and transducers shall have a zeroing capability of readjusting the transmitter zero.
- d. Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.

2. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal.

3. Input Power: Low voltage, nominal 24 Vdc.

B. Temperature Sensors:

1. General: Temperature sensing elements shall have characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy. Sensor shall be UL 873 listed for temperature equipment.

2. Performance Requirements:

a. Thermistor:

- 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
- 2) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.
- 3) Resolution: Plus/minus 0.2 degrees F minimum.
- 4) Heat Dissipation Constant: 2.7 mW per degree C.
- 5) Drift: 0.04 degree F after 10 years within temperature range.

b. RTD:

- 1) Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
- 2) Accuracy (All): Plus/minus 1 degree F minimum, unless otherwise noted below.
 - a) Room Sensor Accuracy: Plus/minus 0.5 degrees F minimum.
 - b) Chilled Water Accuracy: Plus/minus 0.5 degrees F minimum.
 - c) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.
- 3) Resolution: Plus/minus 0.2 degree F.
- 4) Drift: 0.04 degrees F after 10 years within temperature range.

c. Sensing Range:

- 1) Provide limited range sensors if required to sense the range expected for a respective point.

d. Wire Resistance:

- 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.

- 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
 3. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 4. Room Temperature Sensors:
 - a. Construct for surface or wall box, or enclosure with insulated backing suitable for exterior wall mounting.
 - b. Provide the following features:
 - 1) Setpoint reset slide switch, dial wheel, or push-button interface with an adjustable temperature range.
 - 2) Individual heating/cooling setpoint slide switches, dial wheel, or push-button interface.
 - 3) Momentary override request push button for activation of after-hours operation.
 - 4) Integral digital display with the following:
 - a) Indication of space temperature.
 - b) Setpoint adjustment to accommodate room setpoint.
 - c) Display and control fan operation status.
 - d) Manual occupancy override and indication of occupancy status.
 - e) Controller mode status.
 5. Temperature Averaging Elements:
 - a. Use on duct sensors for ductwork 10 sq ft or larger.
 - b. Use averaging elements where prone to stratification with sensor length range between 16-22 ft.
 - c. Provide for all mixed air and heating coil discharge sensors regardless of duct size.
 6. Insertion Elements:
 - a. Use in ducts not affected by temperature stratification or smaller than 10 sq ft.
 - b. Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches for pipe sizes greater than 4 inches.
 - c. Immersion Well Housing: 1/2 inch NPT brass or stainless steel. Stainless steel required for piping 6 inch and larger.
- C. Equipment Operation Sensors:
1. Status Inputs for Airside Equipment:
 - a. Type: Fixed range differential pressure switch with adjustable setpoint.
 - b. Performance Characteristics:
 - 1) Range: Not greater than two times the design fan static pressure.
 - c. Construction:
 - 1) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.
 - 2) Provide Insertion tube for use in duct configurations. Insertion length selected as appropriate for duct size.
 - 3) Contact Type: Single-pole, single-throw (SPST). Provide multiple poles or throw contacts to meet additional alarms required.
 2. Status Inputs for Hydronic Equipment:
 - a. Differential Pressure Switch: Fixed range type with adjustable setpoint.
 - 1) Range: Not greater than two times the design equipment differential pressure.

- 2) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.
- 3) Contact Type: Single-pole, single-throw (SPST). Provide double-throw contacts to meet additional alarms required.
- b. Flow Switch:
 - 1) Thermal dispersion flow switch enclosed in insertion device, of material suitable for fluid encountered and magnetic setpoint coordinated with the desired flow rate.
 - a) Range: Sensitivity suitable for the maximum and minimum design flow rates of the system in which it is installed.
 - b) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered, with LED status indicators for visual switch indication.
 - c) Contact Type: Automatic reset upon regain of flow.
3. Status Inputs for Electric Motors:
 - a. Analog Current Transducer:
 - 1) Type: Split core design, cable of being installed or removed without dismantling the primary bus cables.
 - 2) Performance Characteristics:
 - a) Accuracy: Plus/minus 2 percent of selected range.
 - b) Range: Multi-range device, suitable for the amperage encountered with internal zero and span adjustment.
 - c) Analog output signal: Generate a proportional control signal relative to the amount of current through the primary bus cables.
 - 3) Construction:
 - a) 24 V or Self-powered (passive).
 - b) Provide with integral command relay.
 - c) Device shall accept overcurrent up to twice its trip into range.
 - d) Enclosure: UL 94 approved thermoplastic, rated for V-0. No metal parts shall be exposed other than the terminals.
 - b. Binary Current Sensing Relay:
 - 1) Type: Split core with current transformers, adjustable and set to 175 percent of rated motor current.
 - 2) Self-powered (passive) with solid-state circuitry and a dry contact output.
 - 3) Adjustable trip point.
 - 4) Contact Type: Single-pole, double-throw (SPDT).
 - 5) LED indicating the on or off status.
 - 6) A conductor of the load shall be passed through the window of the device.
 - 7) Device shall accept overcurrent up to twice its trip into range.

2.06 OUTPUT CONTROL DEVICES

- A. Control Relays:
 1. Provide relay with contact rating, configuration, and coil voltage that is suitable for the application.
 2. Provide NEMA 1 enclosure when relay is not installed in a local control panel.
 3. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator.

4. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus/minus 200 percent minimum from setpoint.
 5. Electromechanical relays shall be UL listed, compact in size, provided with quick connect terminals and be impervious to shock and vibration.
 6. Electronic relays shall be microcomputer-based with PI, time proportioning control capability, have average life greater than 500,000 cycles, have a built-in transformer and have LED status indication.
- B. Fan Speed Controllers:
1. Solid-state model providing field-adjustable proportional control of motor speed. Equip with filtered circuit to eliminate radio interference.

2.07 POWER SUPPLIES

- A. Reference Division 23 Section "Direct Digital Controls for HVAC" for DC power supply requirements.
- B. Control power transformers shall meet NEMA/ANSI standards.
- C. Control power transformers shall be UL listed for Class 2 current-limited service or provided with over-current protection on both primary and secondary circuits for Class 2 current-limited service.
- D. Connected load on the transformer shall not exceed 80 percent of the transformer's rated capacity.
- E. The core and windings shall be completely encased in a UL approved thermoplastic. No metal parts shall be exposed other than the terminals.
- F. Performance Characteristics:
1. Accuracy: Plus/minus 1 percent at 5.0 A full scale output.
- G. Provide a disconnect switch for each transformer.

2.08 THERMOSTATS

- A. General:
1. Non-programmable with the following features:
 - a. LCD or LED display screen.
 - b. Temperature information display.
 - c. Setpoint display and adjust.
 - d. Remote temperature sensor interface terminal.
 2. Performance Requirements:
 - a. Accuracy: Plus/minus 1.0 degree F minimum.
 - b. Resolution: Plus/minus 0.2 degrees F.
 - c. Range:
 - 1) Operating Temperature: 32 degrees F to 122 degrees F minimum.
 - 2) Operating Humidity: 0 percent to 95 percent relative humidity, non-condensing.
 - 3) Setpoint Control:
 - a) Cooling: 54 degrees to 100 degrees F.
 - b) Heating: 40 degrees to 90 degrees F.
 - d. Multi-stage as required to match unit cooling and heating stages scheduled on the drawings.

- B. Electric Room Thermostats:
 - 1. Type: 24 volts, two position switch, programmable with setback/setup temperature control.
 - 2. Covers: Locking with set point adjustment and indication.
 - 3. Setpoint functional range: 45 degrees F to 90 degrees F.
- C. Room Thermostat Accessories:
 - 1. Thermostat Covers: Plastic.
 - 2. Insulating Bases: For thermostats located on exterior walls.
 - 3. Thermostat Guards: Locking transparent plastic mounted on separate base.
 - 4. Adjusting Key: As required for device.
 - 5. Aspirating Boxes: Where indicated for thermostats requiring flush installation.
 - 6. Integrated sensors: At the contractor's option, the following sensors may be provided with the thermostat in a single device. Refer to the drawings where additional sensors are required. Refer to "Input/Output Sensors" section of this specification for language governing performance of the integrated sensors.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 EXISTING EQUIPMENT

- A. Wiring: The contractor may reuse any abandoned wires. The integrity of the wire and its proper applications to the installation are the responsibility of the contractor. The wire shall be properly identified and tested. Unused or redundant wiring that remains in place shall be identified as such.
- B. Local Control Panels: The contractor may reuse any existing local control panels to locate new equipment. All redundant equipment within these panels shall be removed. Panel face cover shall be patched to fill all holes caused by removal of unused equipment or replaced with new.
- C. Repair: Unless otherwise directed, the contractor is not responsible for repair or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, notify the engineer immediately.
- D. Temperature sensor wells: The contractor may reuse any existing wells in piping for temperature sensors. The wells shall be modified as required for proper fit of new sensors.
- E. Indicator Gauges: Where these devices remain and are not removed, recalibrate and ensure reasonable accuracy.
- F. Unless otherwise noted, salvage, recondition, and reuse the following devices:
 - 1. Room thermostats.
 - 2. Electronic sensors and transmitters.
 - 3. Controller and auxiliary electronic devices.

4. Damper actuators, linkages, and appurtenances.
 5. Control valves.
- G. Patch holes and finish to match existing walls.

3.03 INSTALLATION

- A. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.
- B. General Workmanship:
1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
 2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
 3. Install all equipment in readily accessible locations.
 4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
 5. Install all products in accordance with manufacturer's instructions.
- C. Sensors:
1. Mount sensors rigidly and adequately for the environment within which the sensor operates.
 2. Provide thermistor type temperature sensors for temperature ranges between minus 30 degrees F to 230 degrees F. Provide RTD type temperature sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
 3. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Coordinate installation of room/space sensors with architect and other trades to ensure a neat and orderly installation.
 4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
 5. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
 6. Verify location and mounting height of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Align with adjacent lighting switches and humidistats.
 - a. Install devices to meet ADA requirements unless otherwise noted on the plans.
 7. Provide separable sockets for liquids and flanges for air bulb elements.
 8. Provide guards on thermostats in areas indicated on the drawings.
 9. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
 10. Install shutoff valves in the high and low pressure reference lines connecting to hydronic pressure sensors and switches. Install a shunt valve across the high and low reference pressure ports for servicing. Valves may be ordered as an integral option with the sensor.
- D. Control Valves:
1. Do not install brass valves in open-loop systems.
 2. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.
 3. Install flanges or unions to allow valve removal and installation.

4. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
 5. Valve Orientation:
 - a. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
 - b. Install valves in a position to allow full stem movement.
 - c. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.
 6. Provide valves with position indicators where sequenced with other controls.
 7. Tag valves in accordance with Division 23 Section, "Identification for HVAC Piping and Equipment."
- E. Control Dampers:
1. Install dampers with extruded aluminum or stainless steel frames and blades in corrosive environments and areas with high humidity.
 2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
 3. Clearance:
 - a. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
 - b. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
 4. Service Access:
 - a. Dampers and actuators shall be accessible for visual inspection and service.
 - b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23 Section, "Air Duct Accessories."
 5. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting.
 6. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
 7. Provide isolation (two position) dampers of parallel blade construction.
 8. Provide opposed blade damper configuration for all other applications.
 9. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
 10. After installation of low-leakage dampers and seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.
- F. Operators:
1. Mount and link control damper actuators according to manufacturer's instructions.
 - a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.
 - b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - c. Provide all mounting hardware and linkages for actuator installation.

2. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.
3. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer.
- G. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- H. Provide an insulation standoff on control devices, cables, and other items that do not require flush mounting to ductwork, piping, or equipment.

3.04 MAINTENANCE

- A. Refer to Division 01 closeout requirements for additional requirements relating to maintenance service.
- B. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

3.05 STARTUP AND DEMONSTRATION

- A. Control Dampers and Valves:
 1. Stroke and adjust control valves and dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
 2. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
 3. For control valves and dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
 4. Verify that all two-position dampers and valves operate properly and that the normal positions are correct.
 5. Verify that all modulating dampers and valves are functional, that the start and span are correct, that direction and normal positions are correct, and that they achieve proper closure.

3.06 DAMPER SCHEDULE

<u>Service</u>	<u>Ruskin Model</u>	<u>Material</u>
Outside, Exhaust and Relief Air Control, Stairway and Shaft Vents	CD-50	Aluminum
Fire/Smoke Damper for Smoke Control	FSD-60	Galvanized Steel
All Other	CD-356	Galvanized Steel

3.07 DAMPER OPERATOR VOLTAGE SCHEDULE

<u>Service</u>	<u>Voltage</u>
Interlocked with HVAC fans	120V
Multi-section dampers	120V
Large dampers (> 60 inches in any dimension)	120V
All other operators control wiring	24V

- A. Note: Coordinate with Division 26 if 120V power is required for operator to achieve appropriate torque requirements for damper actuation.

3.08 CONTROL VALVE SCHEDULES

A. Allowable Valve Type and Size by Control Application:

<u>Valve Type</u>	<u>Control Application</u>	
	<u>Modulating</u>	<u>Two-Position</u>
Globe	≤ 4 IN	≤ 2 IN
Characterized Ball	≤ 4 IN	≤ 4 IN

B. Allowable Valve Body Material by Service Application:

<u>Valve Body Material</u>	<u>Service Application</u>	
	<u>Closed Loop</u>	<u>Open Loop</u>
Bronze	Allowed	Allowed
Brass	Allowed	Not Allowed
Iron	Allowed	Allowed
Stainless Steel	Allowed	Allowed

C. Allowable End Connection by System Material:

1. Copper Tube:
 - a. 2-1/2 Inch and smaller: Threaded ends.
2. Steel Pipe:
 - a. 2 Inch and Smaller: Threaded.

D. Allowable End Connection by Size Schedule:

<u>Valve Type</u>	<u>End Connection Type</u>		
	<u>Threaded</u>	<u>Flanged</u>	<u>Grooved</u>
Globe	≤ 2-1/2 IN	≤ 4 IN	N/A
Characterized Ball	≤ 2-1/2 IN	≤ 3 IN	N/A

END OF SECTION 23 0913

**SECTION 23 2113
HYDRONIC PIPING**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Hydronic piping materials.
- C. Hydronic piping fittings.
- D. Hydronic piping joining materials.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.03 SUBMITTALS

- A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.
- B. Reference Division 23 Section, "Basic Piping Materials and Methods" for additional submittal requirements.
- C. Reports as specified in Part 3 of this Section.

1.04 QUALITY ASSURANCE

- A. Comply with Division 23 Section, "Basic Piping Materials and Methods."
- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this Section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this Section, with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Division 23 Section, "Basic Piping Materials and Methods."

PART 2 - PRODUCTS AND MATERIALS

2.01 HYDRONIC PIPING MATERIALS

- A. Carbon Steel Pipe:
 - 1. NPS 2 inch and Smaller: ASTM A53 or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40, black steel, plain ends.
- B. Galvanized Steel Pipe:
 - 1. NPS 2 inch and Smaller: or A106, Type E electric-resistance welded or Type S seamless, Grade B, Schedule 40 hot-dipped galvanized according to ASTM A123 on both inside and outside of pipe, plain ends.
- C. Copper Tubing:
 - 1. Drawn Temper Tubing: ASTM B306, Type DWV
 - 2. Drawn Temper Tubing: ASTM B88, Type M.
 - 3. Drawn Temper Tubing: ASTM B88, Type L.
 - 4. Annealed Temper Tubing: ASTM B88, Type K.

2.02 HYDRONIC PIPING FITTINGS:

- A. General: Fittings shall be of wall thickness, pressure rating, and material matching adjoining pipe.
- B. Reference Division 23 Section "Basic Piping Materials and Methods" for basic piping materials and fittings.
- C. Threaded:
 - 1. All threads shall conform to ASME B1.20.1.
 - 2. Malleable-Iron: ASME B16.3, standard pattern.
 - 3. Cast-Iron: ASME B16.4, standard pattern.
 - 4. Galvanized: ASTM A197, standard pattern.
- D. Welded:
 - 1. Carbon and Galvanized Steel: ASME B16.9, seamless weld conforming to ASTM A234.
- E. Solder-Joint: Wrought-copper, ASME B16.18 or B16.22, streamlined pattern.
- F. Solder-Joint for DWV Drainage: ASME B16.23, streamlined pattern.
- G. Brazed-Joint: Wrought-copper, ASME B16.50, streamlined pattern.

2.03 HYDRONIC PIPING JOINING MATERIALS:

- A. Reference Division 23 Section "Basic Piping Materials and Methods" for basic joining materials.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Install piping to ASME B31.9 requirements.
- C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.

3.02 PIPE APPLICATION SCHEDULE

- A. Mechanically Joined Hydronic Piping:
 - 1. Contractor shall not use mechanically joined hydronic piping systems for hydronic piping in lieu of welded, threaded or flanged piping methods.
- B. Heating Hot Water Piping, Above Grade:
 - 1. Acceptable Pipe Materials:
 - a. Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
 - b. Type L copper with soldered, brazed, or flanged fittings.
 - c. Stainless steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
 - 2. Fitting Pressure Class: Minimum rating of 150psig.
- C. Chilled Water Piping, Above Grade:
 - 1. Acceptable Pipe Materials:
 - a. Carbon steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
 - b. Type L copper with soldered, brazed, or flanged fittings.

- c. Stainless steel with threaded fittings for pipes 2 inch and smaller, and flanged or welded fittings for pipes 2-1/2 inch and larger.
2. Fitting Pressure Class: Minimum rating of 150 psig.
- D. Condensate Drain Piping:
 1. Acceptable pipe materials for piping located inside the building:
 - a. Galvanized steel with galvanized or malleable-iron threaded or flanged fittings.
 - b. Type M copper with soldered fittings for piping 1 inch and smaller.
 - c. Type DWV copper with soldered fittings for piping 1-1/4 inch and larger.

3.03 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment using jointing system specified.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.04 PIPING INSTALLATION

- A. Provide long radius elbows with a minimum centerline radius of 1-1/2 times the pipe diameter. Short radius elbows with a minimum centerline radius of 1 times the pipe diameter may be used only where space does not permit the long radius elbows.
- B. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.
- C. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
- D. Install branch connections to mains using Tee fittings in main with take-off out the top or side of the main unless otherwise shown on the drawings. Up-feed risers shall have take-off out the top of the main line.
 1. Tee-drilling is prohibited as a means for connecting branch taps into any main.
 2. Bull-head tees are prohibited. Do not install tee fittings in such a way that the flow through the branch leg equals the sum of the flows through the two main legs.
- E. Minimum condensate pipe size shall be 3/4 inch unless otherwise noted on plans.

3.05 PIPE HANGERS AND SUPPORTS APPLICATION

- C. Comply with the requirements of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- A. Provide vibration isolation on piping as specified in Division 23 Section "Vibration Isolation for HVAC."
- B. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	1/2
2-1/2	11	9	1/2

- C. Use copper tube maximum hanger span requirements for PVC and CPVC supports and hangers, unless manufacturer's recommendations specify closer hanger spacing.
- D. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.
- E. Install a support within one foot of each change of direction.

- F. Space supports not more than five feet apart at valves, strainers, or piping accessories in piping larger than 2 inches.

3.06 PIPE JOINT CONSTRUCTION

- A. Reference Division 23 Section, "Basic Piping Materials and Methods" for basic pipe joint construction.
- B. Where more than one pipe material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
- C. Install non-conductive dielectric connections whenever joining dissimilar metals.
- D. Pipe-to-Valve and Pipe-to-Equipment Connection: Install flanges or unions between piping and valves and equipment for servicing. Do not use direct welded, brazed, or soldered connections unless specifically called for in the manufacturer's installation instructions.

3.07 FIELD QUALITY CONTROL

- A. Preparation for Testing:
 - 1. Prepare hydronic piping in accordance with ASME B31.9.
 - 2. Leave joints, including welds, uninsulated and exposed for examination during the test.
 - 3. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 - 4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
 - 5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Pressure Testing:
 - 1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 - 2. Use vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system. Use drains installed at low points for complete removal of the liquid.
 - 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
 - 4. Subject piping system to a hydrostatic test pressure which at every point in the system is 1.5 times the maximum system design pressure but not less than 100 psi. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix I of ASME B31.9, Code For Pressure Piping, Building Services Piping.
 - 5. After the hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leaks. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
 - 6. Provide test reports summarizing the test procedures and results of the tests.
- C. Flushing:
 - 1. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 FPS through all portions of the system.

2. Make all provisions required to isolate HVAC equipment, coils, control valves, automatic flow control valves, pressure independent control valves, and balance valves during flushing.
 3. Isolate new pipe from existing pipe during flushing.
 4. Provide temporary valves, connections, and bypasses where required.
 5. Provide temporary pumps with temporary connections.
 6. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials.
 7. Upon completion of flushing, drain all water from system at low points, and remove, clean, and replace strainers.
 8. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.
- D. Fluid Testing: After filling the system as described under Paragraph "Startup", perform the following fluid test procedures:
1. Circulate the fluid for a minimum of 24 hours with all pumps operating and with shutoff valves and control valves in wide open position to ensure thorough mixing of the antifreeze or glycol solution throughout the system.
 2. Remove fluid from a minimum of three different locations and test fluid samples at an independent testing agency for percentage of antifreeze or glycol. Coordinate with the testing agency for amount of sample needed for proper testing.
 3. If any sample does not meet the specified percentages, remove sufficient fluid from the system, add antifreeze or glycol as required to achieve the specified percentage and repeat the circulation and testing procedures specified above. Coordinate with the water treatment supplier.
 4. After the samples meet the specified percentages, submit to the Owner and Engineer signed and dated test report(s) from independent testing agency that document the location of the sample and the results of the fluid test.
 5. One month prior to end of the warranty period, Contractor shall submit samples to an independent testing agency to test the fluid for percentage of antifreeze or glycol. If the test samples have the specified percentage, submit copies of the test reports to the Owner and Engineer as described above in Paragraph 4. If any sample does not meet the specified percentage, Contractor shall perform the work described above in Paragraphs 3 and 4.

3.08 STARTUP

- A. Fill system and perform initial chemical treatment. For systems with antifreeze or glycol, fill systems with specified percentages. Refer to Division 23 Section "HVAC Water Treatment" for chemical treatment.
- B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- C. Before operating the system perform these steps:
 1. Open valves to full open position. Close coil bypass valves.
 2. Remove and clean strainers.
 3. Check pump for proper direction of correct improper wiring.
 4. Set automatic fill valves for required system pressure.
 5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
 6. Set temperature controls so all coils are calling for full flow.
 7. Check operation of automatic bypass valves.

8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
9. Lubricate motors and bearings.

END OF SECTION 23 2113

SECTION 23 2114
HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Air vents.
- B. Balancing valves.
- C. Combination Piping Packages (Coil Kits).

1.02 SUBMITTALS

- A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.
- B. Product Data: Include rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, component sizes, rough-in requirements, service sizes, and finishes.
 - 1. Balancing Valves and Diverting Fittings: Include flow and pressure drop curves based on manufacturer's testing.
- C. Certificates:
 - 1. Inspection certificates for pressure vessels for compliance with ASTM and ANSI manufacturing standards.
 - 2. Welders' certificates complying with the requirements specified in Article, "Quality Assurance."
- D. Manufacturer's installation instructions.
- E. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list for inclusion in Operating and Maintenance manual.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Comply with ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
- C. Fabricate and stamp air separators, air and dirt separators, expansion tanks, and buffer tanks to comply with ASME BPVC-VIII-1.
- D. Comply with ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.
- E. Comply with AWWA Standards for governing filter media; American Water Works Association, Current Edition.
- F. Hydronic specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 AIR VENTS

- A. Manufacturers:
 - 1. American Wheatley.
 - 2. Amtrol, Inc.
 - 3. Armstrong International.
 - 4. Bell & Gossett; Xylem.
 - 5. John Wood Company.
 - 6. Nexus Valves.
 - 7. Spirax Sarco.
 - 8. Taco, Inc.
- B. Manual Type: Bronze body and nonferrous internal parts; working pressure as defined by the ANSI fitting class of the system, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge and inlet connections.
- C. Automatic Type: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; working pressure as defined by the ANSI fitting class of the system, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection.

2.02 BALANCING VALVES

- A. Manufacturers:
 - 1. American Wheatley.
 - 2. Armstrong Fluid Technology.
 - 3. Bell & Gossett; Xylem.
 - 4. Caleffi.
 - 5. Griswold Controls.
 - 6. Hays Fluid Controls.
 - 7. Hydronic Components Inc.
 - 8. IMI.
 - 9. Nexus Valve.
 - 10. Nibco Inc.
 - 11. Nutech Hydronic Specialty Products
 - 12. Oventrop.
 - 13. Pro Hydronic Specialties.
 - 14. Taco, Inc.
 - 15. Victaulic Company of America.
- B. Construction: Provide balancing valve with fixed orifice flow balancing, flow measurement, and shut-off capabilities, memory stops, and minimum of two differential pressure metering ports.
 - 1. Quarter Turn: Provide ball or butterfly quarter turn style for measurement use in variable flow applications.
 - 2. Full Turn: Provide plug or globe, full or multiple turn style for balancing use in constant flow applications.
 - 3. Size 2 inch and Smaller: Bronze, forged brass or DZR forged brass body, threaded connections.

4. Size 2-1/2 inches and Larger: Cast iron, carbon steel, or ductile iron body, with flanged or grooved connections.
 5. Pressure Rating: Minimum working pressure as defined by the ANSI fitting class of the system.
 6. Maximum operating temperature: 250 degrees F.
- C. Accessories: Valve shall include integral pointer and calibrated scale to register degree of valve opening, with position indication readout for repeatable regulation and control.

2.03 COMBINATION PIPING PACKAGES (COIL KITS)

- A. Combination piping packages are allowed in lieu of individual components specified for hydronic coils and devices containing hydronic coils.
- B. Components shall be same size as piping serving the unit as shown on the drawings. Control valves do not need to be same size as piping subject to the sizing requirements set forth in Division 23 "Instrumentation and Control Devices for HVAC."
- C. Package shall include the components and shall match layouts specified on the Drawings. Each component of the combination piping package shall meet the specifications for the individual components being combined.

PART 3 - EXECUTION

3.01 HYDRONIC SPECIALTY APPLICATIONS

- A. Reference Division 23 Section "General Duty Valves for HVAC Piping" for general duty valve applications.
- B. Air Vents:
 1. Manual Type: High points in the system outside of mechanical rooms, at heat transfer coils, and elsewhere as required for system air venting.
 2. Automatic Type: Air separator outlets, expansion tank connections, high points in outlet piping of boilers and hot water heat exchangers, and elsewhere as required for system air venting within a mechanical room.
- C. Balancing Valves:
 1. Variable Volume Pumping Systems: Where shown on the drawings, sized for the smaller of the pipe size or to have a minimum pressure drop of 1 psig at the design flow rate.

3.02 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.
- C. Air Vents:
 1. Where large air quantities can accumulate, provide enlarged air collection standpipes.
 2. Install manual air vents in piping mains with a tee fitting, 1/2 inch ball valve, threaded nipple, and cap.
 3. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

3.03 STARTUP

- A. Reference Division 23 Section Hydronic Piping for general startup requirements.

END OF SECTION 23 2114

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**SECTION 23 3113
METAL DUCTS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Duct liner.
- C. Duct sealants.
- D. Duct hangers and supports.
- E. Manufactured ductwork and fittings.
- F. Snap-Lock duct system.

1.02 DEFINITIONS

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
 - 1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
 - 2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.04 SUBMITTALS

- A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Duct Liner.
 - 2. Sealing Materials.
 - 3. Fire-Stopping Materials.
- B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
 - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 - 2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
 - 3. Fittings.
 - 4. Reinforcing details and spacing.
 - 5. Seam and joint construction details.
 - 6. Penetrations through fire-rated and other partitions.
 - 7. Terminal heating and cooling unit, and coil installations.

8. Locations of fire and fire/smoke dampers and associated duct access doors.
 9. Location of manual balancing dampers.
 10. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:
1. Coordination with ceiling suspension members.
 2. Spatial coordination with other systems installed in the same space with the duct systems.
 3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
 4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.
- D. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.
- E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.
- C. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
- D. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
- E. NFPA Compliance: Comply with the following NFPA Standards:
1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
 2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."
- F. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Provide ductwork systems in conformance with "HVAC Duct Construction Standards – Metal and Flexible," latest edition.
- G. Underwriter's Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.
- H. National Air Duct Cleaners Association, Inc. (NADCA): Clean ductwork systems in accordance with the standard Assessment, Cleaning and Restoration of HVAC Systems (ACR 2002).

1.06 PROTECTION AND REPLACEMENT

- A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.
- B. Replace duct liner that is damaged and cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installing new duct liner.

1.07 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS AND MATERIALS

2.01 DUCT ASSEMBLIES

- A. Ducts: Galvanized steel, unless otherwise indicated. Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A700.
- B. Supply Air Ducts (constant volume or single zone VAV systems): [3] inches w.g pressure class, galvanized steel.
- C. Primary Supply Air Ducts (upstream of terminal boxes in multizone VAV systems): [4] inches water gauge.
- D. Secondary Supply Air Ducts (downstream of terminal boxes in multizone VAV systems): [2] inches water gauge
- E. Return and Relief: [2] inch w.g. pressure class, galvanized steel.
- F. General Exhaust: 2 inch w.g. pressure class, galvanized steel.
- G. Outside Air Intake: [2] inch w.g. pressure class, galvanized steel.
- H. Combustion Air: [2] inch w.g. pressure class, galvanized steel, aluminum or stainless steel.
- I. Transfer Air and Sound Boots: 1/2 inch wg pressure class, galvanized steel.
- J. Duct Liner Application: Provide duct liner on the following air ducts and where specified on the drawings.
 - 1. Supply Ductwork:
 - a. First 15 feet of ductwork downstream of equipment outlets including exterior ductwork. Refer to Section "HVAC Insulation" for additional insulation requirements for exterior ductwork.
 - 2. Return Ductwork.
 - a. First 15 feet of ductwork upstream of equipment outlets including exterior ductwork. Refer to Section "HVAC Insulation" for additional insulation requirements for exterior ductwork.
 - 3. Transfer Ductwork.

2.02 MATERIALS

- A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A700.
- B. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, lock-forming quality with G90/Z275 coating.. Provide mill phosphatized or galvanized finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.
- C. Duct Liner
 - 1. General:
 - a. Comply with NFPA Standard 90A and North American Insulation Manufacturers Association (NAIMA) Standard AHC-101.
 - b. Liner shall have a flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84 or UL 723.

- c. Duct sizes on mechanical plans indicate clear inside airflow dimensions. Sheet metal sizes for ductwork with duct liner shall be increased accordingly to account for liner thickness.
- 2. Fiberglass: ASTM C1071, Type I or II, glass fibers firmly bonded together with a thermosetting resin with surface exposed to airstream coated to prevent erosion of glass fibers. Liner surface shall serve as a barrier against infiltration of dust and dirt, shall meet ASTM C 1338 for fungi resistance and shall be cleanable using duct cleaning methods and equipment outlined by NAIMA Duct Cleaning Guide. Duct liner shall be rated for air velocity of 6,000 fpm.
 - a. Rectangular fiberglass duct liner shall be Certainteed ToughGard T, JohnsManville Linacoustic RC, Knauf Atmosphere, Owens Corning QuietR or approved equal.
 - 1) Thickness and Density:
 - a) 1-1/2 inch, 1-1/2 pounds per cubic foot.
 - b. Round fiberglass duct liner shall be Certainteed ToughGard UltraRound, JohnsManville Spiracoustic Plus, Owens Corning QuietZone Spiral, or approved equal.
 - 1) Thickness and Density:
 - a) 1-1/2 inch, 4 pound per cubic foot.
 - c. Thermal Performance: Meet minimum "K-Factor" equal to 0.28 (Btu-in/h-sq ft-F) or better, at a mean temperature of 75°F and rated in installed condition in accordance with ASTM C518 and/or ASTM C177.
 - d. Noise Reduction Coefficient (NRC): Meet the following minimum NRC in accordance with ASTM C423 Type A Mounting:
 - 1) 1-1/2 Inch Thick: NRC 0.80.
 - e. Liner Adhesive: Comply with NFPA Standard 90A /UL 181 classified with flame spread/smoke development less than 25/50 and ASTM C 916. Adhesive shall be a minimum 35% solid content, water-based, non-oxidizing and have a service temperature of -20 to 200 F. Water-based adhesive shall be one of the following:
 - 1) Design Polymerics DP 2502.
 - 2) Duro Dyne WIT.
 - 3) Foster 85-60.
 - 4) Childers CP-127.
 - 5) Johns Manville SuperSeal.
 - 6) Hardcast Coil-Tack.
 - f. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.
 - 1) Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.
 - 2) Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.
- 3. Flexible Elastomeric Duct Liner: Insulation material shall be a flexible, closed cell, elastomeric insulation in sheet form that complies with ASTM C534. Material shall have a maximum thermal conductivity of 0.27 Btu-in/h-sf-F and a minimum water vapor transmission of 0.08 perm-inches. Liner shall be 1 inch thick or greater to meet local code requirements.

- a. Manufacturers:
 - 1) Aeroflex USA, Inc Aerocel Sheet.
 - 2) Armacell LLC, AP Armaflex SA or Amaflex Ultra.
 - 3) K-Flex USA Liner Gray.
4. Flexible Elastomeric Acoustical and Conformable Duct Liner: Compliance with ASTM C 534 Grade 1, Type II or ASTM C 1534, NFPA 90A or NFPA 90B, Thickness: 1/2 inch and 1 inch, Thermal Conductivity: 0.25 BTU-in/hr sq ft F at 75 F mean temp, ASTM C 518, Noise Reduction Coefficient: 0.6, ASTM C 423, Sound Transmission Class (STC) 25, ASTM E 90, EPA registered anti-microbial additive to inhibit mold and mildew, ASTM G21.
 - a. Manufacturers:
 - 1) Aeroflex USA, Inc PLUS Acoustical Duct Liner.
 - 2) Armacell LLC, AP Coilflex.
 - 3) Approved equal.
5. Flexible Elastomeric Round or Spiral Duct Liner: Compliance with ASTM C 534 Grade 1, Type II or ASTM C 1534, NFPA 90A or NFPA 90 B, Thickness: 1 inch, Thermal Conductivity: 0.28 Btu-in/hr sq ft F at 75 F mean temp, ASTM C 518 Noise Reduction Coefficient: 0.4, ASTM C 423 Sound Transmission Class (STC) 31, ASTM E90, EPA registered anti-microbial additive to inhibit mold and mildew, ASTM G21.
 - a. Manufacturers:
 - 1) Armacell LLC, AP Spiraflex.
 - 2) Approved equal.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 2. Surface Burning Characteristics: Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.
 3. For Use with Flexible Ducts: UL labeled.
 4. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics. Duct tape shall not be used as a sealant on any ducts.
 5. Joint and Seam Tape: 2 inches wide, glass-fiber-reinforced fabric.
 6. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.
 7. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 65 percent solids. Approved products: Design Polymeric DP 1090, Duro Dyne SGD, Fosters 32-14, or approved equal.
 8. Water-Based Joint and Seam Sealant: Non-Fibrated, UL 181 listed, rated to minimum SMACNA Pressure Class of ± 10 inches w.g and SMACNA Seal Class A. Sealant shall have a minimum service temperature range of 20 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymeric DP 1010, Ductmate Proseal, Duro Dyne Duroseal EDS-RS, Fosters 32-18, Hardcast Iron-Grip 601, Red Devil D-Seal and United McGill United Duct Seal WB.
 9. Water-Based Joint and Seam Sealant: Fiber reinforced, UL 181 listed, rated to minimum SMACNA Pressure Class of ± 10 inches w.g and SMACNA Seal Class A. Sealant shall have a minimum service temperature range of 20 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymeric DP 1030, Ductmate

Fiberseal, Duro Dyne Duroseal EDS-RF, Fosters 32-17, Hardcast CCWI-181, Red Devil F-Seal 181 or United McGill Uni-Mastic.

10. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
11. Flanged Gasket Tapes: Butyl gasket shall be UL 181 classified. Gasket size shall be minimum 5/8 inch x 3/16 inch and have nominal 100 percent solid content. It shall be non-oxidizing, non-skinning and have a service temperature of -25 to 180 F. Approved Products: Design Polymerics DP 1040, Ductmate 440, and Hardcast 1104.

E. Fire Stopping

1. Fire-Resistant Sealant: Two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
2. Fire-Resistant Sealant: One-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
3. Products: Subject to compliance with requirements, provide one of the following:
 - a. "3M Fire Stop Foam"; 3M Corp.
 - b. "SPECSEAL Pensil 200 Silicone Foam"; Specify Technology, Inc.
 - c. 3M Fire Stop Sealant"; 3M Corp.
 - d. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
 - e. "Fyre Putty"; Standard Oil Engineered Materials Co.
 - f. "FS-ONE", Hilti, Inc.

F. Hangers and Supports

1. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
2. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
3. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
4. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
 - a. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
 - b. Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.
5. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

6. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
 - a. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
 - b. For stainless steel ducts, provide stainless steel support materials.
 - c. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.
- G. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.
- H. Tie Rods: Same material as the duct, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 DUCTWORK FABRICATION

- A. Fabricate and support duct in accordance with latest edition of SMACNA (DCS).
- B. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
 1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.
 2. Fabricate ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
- C. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- D. Cross breaking or Cross Beading: Cross break or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.
- E. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.
- F. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.
- G. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer's approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section "Ductwork Accessories" for turning vane construction and mounting.
- H. Provide full radius elbows for ductwork installed in noise critical spaces. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. Where space does not permit the installation of radius elbows, provide mitered elbows with sound attenuating, acoustical turning vanes. Refer to Section "Ductwork Accessories" for acoustical turning vanes.

- I. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- J. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.
- K. Round Duct Fabrication
 - 1. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.
 - a. Fabricate round ductwork of minimum 26 gauge sheet metal.
- L. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.
- M. Round Fittings Fabrication
 - 1. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-5, 3-6 and 3-7 and with metal thickness specified for longitudinal seam straight duct.
 - 2. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
 - 3. Elbows: Unless elbow construction type is indicated, provide elbows meeting the following requirements:
 - a. Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter.
 - 1) Elbows in Round Duct: Provide full radius elbows.
 - 2) The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.
 - 3) Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces.
 - b. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.
 - 1) Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-1.
 - 2) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:
 - a) 3 to 26 inches: 24 gauge.

- 3) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:
 - a) 3 to 14 inches: 24 gauge.
 - b) 15 to 26 inches: 22 gauge.
 - 4) 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.
 - c. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
 - d. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.
 - e. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
 - f. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.
 - g. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.
 - h. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gauge.
- N. Shop Application of Liner in Rectangular Ducts
1. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.
 2. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
 3. Butt transverse joints without gaps and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.
 5. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.
 - a. Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.
 6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 7. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:
 - a. Fan discharge.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where duct velocity is greater than 2,500 FPM.
 8. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets,

or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

- A. General: At the Contractor's option, factory-manufactured ductwork can be provided instead of fabricated ductwork for round and oval ductwork. The round duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer. The oval duct system shall be sealed with duct sealer as specified.
1. Ducts shall be calibrated to manufacturer's published dimensional tolerance standard.
 2. All duct 14" diameter and larger shall be corrugated for added strength and rigidity.
 3. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.
 4. Ducts shall be constructed using spiral lock seam sheet metal construction.
 5. Ductwork to be installed in exposed locations shall have the surface prepared in the factory for field painting.
- B. Duct Construction
1. Unless otherwise noted, all duct and fittings shall be constructed from galvanized steel in accordance with SMACNA's Duct Construction Standards for +10" water gauge pressure with minimum wall thickness as shown in the following tables.
 2. Duct shall be calibrated to manufacturer's published dimensional tolerance standard.
 3. Ducts shall be constructed using spiral lock seam sheet metal construction.
 4. Ductwork to be installed in exposed locations shall be factory-prepared for field painting, i.e. mill-phosphatized.

Single Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct (ga)	Galvanized Fittings (ga)
3-14	28	24
15-24	26	24

- C. Fittings:
1. All fitting ends for round duct and transitions and divided flow fittings smaller than 24" diameter that convert oval duct to round duct shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to ensure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.
 2. All fittings shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.
 3. All fitting ends from 5" to 60" diameter shall have rolled over edges for added strength and rigidity.
 4. All elbows from 5" to 12" diameter shall be 2 piece die stamped and continuously stitch welded. All elbows 14" diameter and larger shall be standing seam gorelock construction and internally sealed.
 5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0. The radius of all 15°, 30° and 60° elbows shall be minimum 1.0 times the elbow diameter.

6. All fittings that are of either spot welded or button punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct tape is unacceptable except for retrofit installations.
7. All volume dampers shall be Lindab Safe type DRU, DSU or DTU or equal by an acceptable manufacturer. Damper shall be fitting sized to slip into spiral duct. Damper shall have the following features:
 - a. Locking quadrant with blade position indicator.
 - b. 2" sheet metal insulation stand-off.
 - c. Integral shaft/blade assembly.
 - d. Shaft mounted, load bearing bushings.
 - e. Gasketed shaft penetrations to minimize leakage.
- D. Manufacturers:
 1. Hercules Industries.
 2. Hranec Corporation.
 3. Lewis & Lambert.
 4. Lindab Safe.
 5. Linx Industries, Inc.
 6. Semco.

2.05 SNAP-LOCK DUCT SYSTEM

- A. General: At Contractor's option, snap-lock round ductwork can be provided instead of fabricated ductwork for round ductwork up to 14" in diameter in air systems with pressures between negative 1" and positive 2" w.c..
- B. Duct Construction:
 1. Material:
 - a. Galvanized steel conforming to ASTM A653 and A924 with G-60 galvanized coating conforming to ASTM A653 and ASTM A90.
 2. Duct shall be minimum 26 gauge. Duct shall be self-locking and incorporate a factory applied gasket in the longitudinal seam and the female end of the traverse joint to provide a system that meets SMACNA Seal Class A.
 3. Fittings: Minimum 26 gauge. All high-efficiency take-offs, conicals, and collars shall have a factory applied gasket along all rivets, co-latches, and flanges. Dampened fittings shall have low leakage hardware with closed-end bearings.
- C. Gaskets: Gaskets shall be made of butyl and EPDM rubber that meets flame spread index of 25 and smoke spread index of 50 according to ASTM E84.
- D. Manufacturers:
 1. Ductmate GreenSeam.
 2. Approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install products in accordance with manufacturer's instructions.
- C. Install ducts with the fewest possible joints.

- D. Seal duct joints with the appropriate sealing material.
- E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- J. Install insulated ducts with 1-inch clearance outside of insulation.
- K. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- L. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- M. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.
- N. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- O. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.
- P. Acoustical Barrier Penetrations: Where a duct passes through a wall, ceiling or floor slab of a noise critical space, provide a clear annular space of 1-inch between the duct and the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The Contractor shall check the clearance and, if clearance is acceptable, shall install the duct and pack the voids full depth with mineral fiber batt insulation. Contractor shall caulk both ends with a non-aging, non-hardening sealant backed by a polyethylene foam rod or permanently flexible firestop material. Where there is insufficient clearance space, Contractor shall place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.
- Q. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.
- R. Duct Liner Installation
 - 1. Fiberglass Duct Liner:
 - a. Attach fiberglass duct liner using fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.
 - 2. Flexible Elastomeric Duct Liner:
 - a. Install liner in accordance with the manufacturer's installation instructions or ASTM C 1710.
 - b. Attach flexible elastomeric duct liner to clean, oil-free sheet metal surfaces with adhesive as recommended by the liner manufacturer.

- c. Seal all longitudinal seams and end joints with manufacturer's recommended adhesive and install compression joints in accordance with manufacturer's instructions to eliminate any openings in insulation that would allow passage of air to duct surface being insulated.
- S. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- T. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- U. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- V. Seam and Joint Sealing
 - 1. General: Seal duct seams and joints as follows:
 - a. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.
 - b. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized. Transfer air ducts and sound boots do not need to be sealed.
 - 2. Seal externally insulated ducts prior to insulation installation.
 - 3. Ductwork installed exterior to the building without weather-proof jacket or cladding shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.
 - a. Lined Ductwork: Where exterior ductwork is specified on the drawings to be provided with interior lining for thermal or sound performance requirements, seal the longitudinal and transverse joints with sealant rated for exterior exposure.
- W. Hanging and Supporting
 - 1. Install rigid round, rectangular, and flat oval metal duct with support systems per SMACNA standards.
 - 2. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer's recommended load rating.
 - a. Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.
 - 3. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
 - 4. Support vertical ducts at a maximum interval of 16 feet and at each floor.
 - 5. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.
 - 6. Install concrete insert prior to placing concrete.
 - 7. Install powder actuated concrete fasteners after concrete is placed and completely cured.
 - 8. Provide double nuts and lock washers on threaded rod supports.
 - 9. 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.

X. Penetrations

1. Fire Barrier Penetrations: Where ducts pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.
2. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Seal ducts that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Basic Piping Materials and Methods" for special sealers and materials.

Y. Connections

1. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."
2. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards".
3. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards". Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."
4. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards".

3.02 ADJUSTING AND STARTUP

- A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "Testing, Adjusting and Balancing for HVAC" for requirements and procedures for adjusting and balancing air systems.
- B. Vacuum duct systems prior to final acceptance to remove dust and debris.
- C. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.
- D. If permanent HVAC equipment is used during the construction period, provide temporary filters at all openings in the ductwork and at inside equipment to protect the system from dust, dirt, paint, and moisture. Replace and maintain filters when needed, but not less than every month. On the day of substantial completion, clean the duct system and provide a new set of filters in the HVAC unit.
 1. Refer to Division 23 Section "Particulate Air Filtration" for filter requirements.

END OF SECTION 23 3113

SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Turning vanes.
- B. Backdraft dampers.
- C. Combination fire and smoke dampers.
- D.
- E. Duct hardware.
- F. Fire dampers.
- G. Flexible duct connectors.
- H. Volume control dampers.
- I. Duct opening closure film.
- J. Cable operated damper systems.
- K. Flexible ductwork.

1.02 SUBMITTALS

- A. Product Data: Provide for each type of ductwork accessory the following:
 - 1. Electrical characteristics.
 - 2. Connection requirements.
 - 3. Dimensions.
 - 4. Capacities.
 - 5. Pressure drops,
 - 6. Leakage rates.
 - 7. Materials of construction.
- B. Shop Drawings: Indicate for shop fabricated assemblies the following:
 - 1. Interfacing requirements with ductwork.
 - 2. Method of fastening or support.
 - 3. Methods of assembly of components.
- C. Performance Data: Submit performance data for duct silencers including insertion loss performance in octave bands from 63 Hz to 8,000 Hz and pressure drop at specified airflow.
- D. Project Record Drawings: Record actual locations of access doors and test holes.
- E. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual.

1.03 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. SMACNA Compliance: Comply with applicable portions of SMACNA (DCS) "HVAC Duct Construction Standards Metal and Flexible".
- C. UL Compliance:
 - 1. Fire Dampers: Construct, test, and label fire dampers in accordance with current edition of UL Standard 555 Standard for Fire Dampers.

2. Smoke Dampers: Construct, test, and label smoke dampers in accordance with current edition of UL Standard 555S Standard for Smoke Dampers.
3. Flexible Ductwork: Construct flexible ductwork in compliance with UL Standard 181 Factory-Made Air Ducts and Connections.
4. Duct Tape: Label in accordance with UL Standard 181B and marked 181B-FX.
5. Duct Clamps: Label in accordance with UL Standard 181B and marked 181B-C.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated
- E. NFPA Compliance:
 1. Comply with applicable provisions of NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems and NFPA 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems pertaining to installation of ductwork accessories.
 2. Comply with NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations for fire-rated grease exhaust ducts.
- F. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 "Standard Test Method for Surface Burning Characteristics of Building Materials" (NFPA 255) method.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect ductwork accessories during shipping and storage from dirt, debris and moisture damage.
- B. Protect dampers from damage to operating linkages and blades.

1.05 SPARE PARTS

- A. Extra Fusible Links: One link for every 10 installed of each type, size and temperature range. Obtain receipt.

PART 2 - PRODUCTS

2.01 TURNING VANES

- A. Manufacturer:
 1. Aero Dyne Co.
 2. Anemostat Products Div.; Dynamics Corp. of America.
 3. Ductmate Industries.
 4. Duro Dyne Corp.
 5. Elgen Manufacturing Co., Inc.
 6. Hart & Cooley Mfg. Co.
 7. Register & Grille Mfg. Co., Inc
 8. Sheet Metal Connectors, Inc.
- B. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed.
 1. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration.
 2. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened.
 3. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.

- C. Acoustical Turning Vanes: Provide acoustical turning vanes constructed of airfoil shaped aluminum extrusion with perforated faces and fiberglass fill in systems serving noise critical spaces. Refer to Section "Common Work Results for HVAC" for noise critical spaces.

2.02 BACKDRAFT DAMPERS

- A. Manufacturers:
1. Air Balance, Inc.
 2. Arrow United Industries.
 3. Cesco
 4. Greenheck
 5. Louvers & Dampers, Inc.
 6. Nailor Industries, Inc.
 7. Pottorff
 8. Ruskin Mfg. Co.
 9. TAMCO
 10. Vent Products
- B. Backdraft Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to open at indicated static pressure. Provide adjustment device to permit setting for varying differential static pressure
1. Construct frames of minimum 16 gauge galvanized steel or 10 gauge aluminum.
 2. Construct blades of minimum 16 gauge aluminum.
 3. Provide minimum 1/2" diameter, corrosion-resistant bearings and 1/2" diameter, galvanized or stainless steel axles.
 4. Mechanically lock blade edge seals into blade edge. Provide neoprene seals for round dampers and silicone or vinyl seals for rectangular dampers.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
1. Air Balance, Inc.
 2. Cesco Products.
 3. Greenheck
 4. Louvers & Dampers, Inc.
 5. Nailor Industries, Inc.
 6. Pottorff
 7. Prefco Products, Inc.
 8. Ruskin Mfg. Co.
- B. General: Provide combination fire and smoke dampers at locations indicated on the drawings. Damper ratings shall be as required to maintain the fire and/or smoke ratings noted on the architectural drawings. Provide duct access door for inspection and service to each fire and smoke damper and fusible link as required. Provide sleeves of length as required to meet the installed location. Damper assemblies shall be provided as a single unit from the manufacturer.
- C. Fabricate dampers in accordance with NFPA 90A, UL555 (current edition) classified fire damper of rating required for location installed, UL555S (current edition) classified smoke damper for leakage class II and rated for dual directional airflow.
- D. Fire/smoke dampers shall be rated for closure in ducts up to minimum velocity of 2,000 fpm and static pressure of 4" w.g.

- E. Multiple Blade Dampers:
 - 1. Frame: Minimum 16-ga galvanized steel. Construct casings of 16 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.
 - 2. Blades: Minimum 22 gauge thickness with airfoil or longitudinal grooved shape for airflow velocities up to 2,000 fpm and airfoil shape for airflow velocities greater than 2,000 fpm.
 - 3. Bearings: Self-lubricating, turning in extruded hole in the frame.
 - 4. Linkage: Plated steel axles, linkage concealed in frame, 1/2" actuator shaft.
 - 5. Seals: Flexible, stainless steel jamb seals, silicone rubber blade seals with galvanized steel mechanical locked in to the blade edge and stainless steel spring loaded leakage seals in sides of casing. Provide stainless steel spring loaded leakage seals in sides of casing, and the following additional features:
- F. Operators:
 - 1. UL listed and labeled.
 - 2. Spring return open/fail closed operation.
 - 3. Two-position or modulating as required for the installation.
 - 4. Electric type suitable for 120 Volts, single phase, 60 Hz.
 - 5. Factory installed on dampers.
 - 6. All operators shall open in between 7 and 15 seconds and close in between 7 and 15 seconds after alarm or smoke detection has occurred.
 - 7. Rated for a minimum of 20,000 cycles of operation.
 - 8. Provide automatic reset of damper upon cessation of detector (test or actual smoke detection), and normalization of duct air temperature.
- G. Electro Thermal Link: Provide resettable temperature device rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated.
- H. Smoke Activation:
 - 1. Provide terminal block for connection to the building fire alarm system.
- I. Accessories:

2.04 DUCT HARDWARE

- A. Manufacturers:
 - 1. Ductmate Industries.
 - 2. Elgen Manufacturing Co., Inc.
 - 3. Ventfabrics, Inc.
 - 4. Young Regulator Co.
- B. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated.
 - 1. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
 - 2. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
- C. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.05 FIRE DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. Cesco Products.
 - 3. Greenheck
 - 4. Louvers & Dampers, Inc.
 - 5. Nailor Industries, Inc.
 - 6. Pottorff
 - 7. Prefco Products, Inc.
 - 8. Ruskin Mfg. Co.
- B. General: Provide fire dampers at locations indicated on the drawings. Damper ratings shall be as required to maintain the fire ratings noted on the architectural drawings. Provide duct access door for inspection and service to each fire damper and fusible link as required. Provide sleeves of length as required to meet the installed location.
- C. Fabricate in accordance with NFPA 90A and UL 555 and as indicated.
- D. Fire dampers shall be dynamic-rated for closure under pressure.
- E. Provide positive lock in closed position.
- F. Ceiling Radiation Dampers
 - 1. General: Conform to UL 555C or tested in accordance with UL 263.
 - 2. Casing: Galvanized steel frame in gauges as required to maintain applicable UL classification.
 - 3. Damper Blades: Galvanized steel with UL classified thermal insulation as required to meet UL criteria and fire and smoke ratings noted on the architectural drawings.
 - 4. Fusible link: Integral to device, rated at 165 degrees F.
 - 5. Accessories: Provide as required for the installation:
 - a. Volume Controller: Manually adjustable volume controller integral to the assembly used to regulate airflow through the damper for testing and balancing.
 - b. Boot Fitting: Factory provided elbow, end or straight type. Include field provided collar, flanged recess, or ceramic thermal blanket.
 - c. Box Fitting: Factory provided 26 gauge with field provided collar, flanged recess, or ceramic thermal blanket.
- G. Horizontal Dampers: Minimum 22 gauge galvanized steel frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket. Construct casings of 20 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.
- H. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream. Construct frames of 20-gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings.
- I. Multiple Blade Dampers: Minimum 16 gauge, galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock. Construct frames of 20-gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings
- J. Fusible links: UL 33 rated at 160 to 165 degrees F unless otherwise indicated.
- K. Accessories:

2.06 FLEXIBLE DUCT CONNECTORS

- A. Manufacturers:
 - 1. Carlisle HVAC Products.
 - 2. Ductmate Industries.
 - 3. Duro Dyne Corp.
 - 4. Elgen Manufacturing Co., Inc.
 - 5. Ventfabrics, Inc.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated. Flexible connectors shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
- C. Flexible Duct Connections: Fabric crimped into metal edging strip. Provide metal compatible with connected ducts. Factory fabricated. Flame-retardant or noncombustible fabrics compliant with NFPA 701.
 - 1. Indoor Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric compliant with NFPA 90A.
 - a. Minimum Weight: 26 oz./sq. yd.
 - b. Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - c. Service Temperature: Minus 40 to plus 200 deg F.
 - 2. Metal: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of minimum 24 gauge galvanized sheet steel or 0.032-inch- thick aluminum.
- D. Maximum Installed Length: 14 inch.
- E. Coatings and Adhesives: Comply with UL 181, Class 1.

2.07 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. Arrow United Industries
 - 3. Cesco
 - 4. Greenheck
 - 5. Louvers & Dampers, Inc.
 - 6. Nailor Industries, Inc.
 - 7. Pottorff
 - 8. Rossi Air Flow
 - 9. Ruskin Mfg. Co.
 - 10. TAMCO
 - 11. Vent Products
- B. Fabricate dampers in accordance with SMACNA (DCS) and as indicated. Construct using galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments.
- C. Single Blade Dampers:
 - 1. Fabricate for duct sizes up to 12 x 36 inch.
 - 2. Blade: 20 gauge, 0.04 inch, minimum.

- D. Multi-Blade Damper: Fabricate of parallel or opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
 - 1. Blade: 18 gauge, 0.0478 inch, minimum.
- E. Bearings: Corrosion resistant, molded synthetic.
- F. Axles: Positively lock into the damper blade.
- G. Blade Seals: Where used for shutoff duty, provide Neoprene seals for round dampers and silicone for rectangular dampers.
- H. Quadrants:
 - 1. Provide locking, indicating quadrant regulators.
 - 2. On insulated ducts, provide extended shafts and mount regulator on standoff bracket, base or adapter.
 - 3. Where rod lengths exceed 48 inches, provide regulator at both ends.

2.08 DUCT OPENING CLOSURE FILM

- A. Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
- B. Thickness: 2 mils.
- C. High tack water-based adhesive.
- D. UV stable.
- E. Elongation Before Break: 325 percent, minimum.

2.09 CABLE OPERATED DAMPER SYSTEMS

- A. Manufacturer:
 - 1. DuroDyne, DuroZone.
 - 2. Metropolitan Air Technology, Inc. (Reference model number for round damper is RT-250 and for rectangular damper is RT-200).
 - 3. Young Regulator Co. (Reference model number is 270).
- B. General: Where access to dampers through a hard ceiling is required, provide a concealed, remote cable-operated, butterfly-type volume damper assembly with external worm gear operator.
- C. Damper assembly shall include duct casing with rolled bead stiffeners, reinforced blade, self-lubricating bearing, and remote operator mounting plate.
- D. Adjustable through the diffuser frame with standard 1/4 inch nut-driver or flat screwdriver.
- E. Cable assembly shall attach to damper as a single piece with no linkage adjustment required.
- F. Positive, direct, two-way damper control with no sleeves, springs or screw adjustments to come loose after installation.
- G. Cable length as required to span the distance from the damper to the remote operator location.
- H. Where approved by Architect, a ceiling cup with cover plate can be used for access to cable operator.

2.10 FLEXIBLE DUCTWORK

- A. Manufacturers:
 - 1. ATCO Rubber Products.
 - 2. Flexmaster.
 - 3. JPL (J.P. Lamborn Co)
 - 4. Thermaflex.

- B. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regard to required quality of construction and materials.
- C. Insulated Flexible Ductwork: Provide duct fabric of ply-vinyl film, polyethylene film or multiple layers of aluminum laminate supported by helically wound spring steel wire. Wrap fabric with fiberglass insulation and provide fire retardant polyethylene or reinforced metalized protective vapor barrier as specified herein.
 - 1. Duct pressure class up to and including 6" w.g.
 - a. Fire retardant polyethylene vapor barrier
 - 1) ATCO 80 Series
 - 2) Flexmaster Type 5B
 - 3) JPL Type PR Series
 - 4) Thermaflex Type G-KM
 - b. Reinforced metalized vapor barrier
 - 1) ATCO 30 Series
 - 2) Flexmaster Type 5M
 - 3) JPL Type MHP Series
 - 4) Thermaflex Type M-KE
 - 2. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.
 - 3. Provide acoustical, fiberglass insulated duct with minimum R-value of R-6.0.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Provide vanes in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease or dryer exhaust ductwork.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Provide combination fire and smoke dampers, fire dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction.
 - 1. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
 - 2. Coordinate all smoke and fire/smoke damper installation, wiring, and checkout to ensure that the dampers function properly and that they respond to the proper fire alarm system signal.
 - 3. Install ceiling radiation dampers per manufacturer's instructions. Support damper assembly from structure.

4. Demonstrate re-setting of fire and fire/smoke dampers to Owner's representative.
- E. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc, Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
 1. Provide duct access doors in ductwork at the following locations
 - a. At each change in direction and at maximum 50-foot (15-m) spacing.
 - b. Upstream [and downstream] from turning vanes.
 2. Provide duct access door(s) as scheduled below, at each fire and smoke damper within 12 inches of the device to allow for testing and maintenance. Label each door (with minimum 1" lettering) indicating which damper type is served. Door shall be capable of being fully opened or provide removable door.

DUCT ACCESS DOOR SCHEDULE		
Duct Width/Depth	Door Size	Quantity
10" TO 12"	10 X 10	1
14" TO 18"	12 X 12	1
20" TO 36"	14 X 14	1
38" TO 54"	18 X 18	1
56" TO 72"	18 X 18	2 (1 EACH END)
74" TO 96"	20 X 20	2 (1 EACH END)

3. As an alternate to duct access door for fire damper access in ducts 12 inch and smaller in each direction, a removable duct section can be provided. The duct section shall be Langdon Inc. "Sure Clamp Access" or approved equal with the following features:
 - a. Be removable without use of tools.
 - b. Be within 4 inches of the damper sleeve break away connection.,
 - c. Be insulated same as connected ductwork.
 - d. Have same pressure rating as the duct.
 - e. Have gaskets at seams to seal the connections.
4. Provide duct access doors for cleaning kitchen exhaust ducts in accordance with NFPA 96. Review locations prior to fabrication.
- F. Provide flexible duct connections wherever ductwork connects to vibrating equipment and when transitioning between two different metallic duct materials (e.g., aluminum to galvanized steel). Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.
 1. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
 2. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- G. Provide volume control dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual volume control damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.
- H. Provide cable operated volume dampers with remote operators where access to dampers through a hard ceiling is required.
 1. Support cable assembly to avoid bends and kinks in cable.
- I. Install fire rated duct wrap in accordance with manufacturer's instructions to provide the fire rating of the material as tested per UL requirements. Joints at insulation seams, banding, pins, and fire

stop systems shall be installed as per manufacturers UL Listing and manufacturers published installation instructions. Overlap seams, install stainless steel bands and/or pins to secure wrap to duct and fill annular spaces in floor and wall penetrations with UL rated forming materials and/or putty to maintain the integrity of the system.

- J. Install flexible ductwork in accordance with manufacturer's instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.
 - 1. Flexible ductwork runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.
 - 2. Install flexible ductwork straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible ductwork fully extended minimizing compression.
 - 3. Provide continuous length with no intermediate joints.
 - 4. Support flexible ductwork from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.
 - 5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.
 - 6. Support straps/saddles shall be minimum 1-1/4" wide. Use of wire hanging systems shall utilize strap and connect wire to strap.
 - a. Factory installed suspension systems are acceptable
 - 7. Do not crimp flexible ductwork against joist or truss members, pipes, conduits, etc.
 - 8. Install flexible ductwork with bend radius at the center line equal to or greater than one duct diameter.
 - a. Support bends approximately one duct diameter on both sides of bends.
 - 9. Connect flexible ductwork to sheet metal ductwork and air devices with at least 1" overlap.
- K. Provide rigid duct elbow where a 90 degree elbow is required at connection to air devices.
- L. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.03 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- B. After start-up, final corrections and balancing of systems, test duct silencers by taking octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations, as directed. Refer to Division 23 Section "Testing, Adjusting and Balancing of HVAC" for additional requirements.
 - 1. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements.
 - 2. Submit complete report of test results including sound curves.

3.04 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
- B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".
- C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".

- D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 3300

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SECTION 23 3423
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Inline centrifugal fans.

1.02 SUBMITTALS

- A. General: Submit data in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements. Include the following:
 - 1. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
 - 2. Materials gages and finishes, including color charts.
 - 3. Dampers, including housings, linkages, and operators.
- C. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
- D. Wiring Diagrams: Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
- E. Maintenance Data: Include instructions for lubrication, motor and drive replacement and spare parts list.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Fan Belts: One set for each individual fan.

1.03 QUALITY ASSURANCE

- A. AMCA Compliance: Provide products that meet AMCA certified performance and sound ratings and are licensed to use the AMCA Seal.
- B. UL Compliance: Fans and fan motors shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."
- C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.
- D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.05 FIELD CONDITIONS

- A. Permanent fans may not be used for ventilation during construction.

PART 2 - PRODUCTS AND MATERIALS

2.01 POWER VENTILATORS - GENERAL

- A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished; with indicated capacities and characteristics.
- B. Statically and Dynamically Balanced: Fans and shafts shall be statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.
 - 1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.
- C. Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210 "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating".
- D. Sound Ratings: Comply with AMCA 301 "Certified Ratings Program Product Rating Manual for Fan Sound Performance". Test fans in accordance with AMCA Standard 300 "Reverberant Room Method for Sound Testing of Fans".
- E. Fabrication: Comply with AMCA 99.
- F. Motors: Refer to Section "Common Motor Requirements for HVAC Equipment" for requirements.
- G. Factory Finish: The following finishes are required:
 - 1. Sheet Metal Parts: Prime coating prior to final assembly.
 - 2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.02 INLINE CENTRIFUGAL FANS

- A. Manufacturers:
 - 1. Acme Engrg. & Mfg. Corp.
 - 2. Carnes Company, Inc.
 - 3. Cook (Loren) Co.
 - 4. Greenheck Fan Corp.
 - 5. PennBarry.
 - 6. Twin City Fan Company
- B. Fan Unit: Inline, direct driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.
- C. Housing: Galvanized steel or split, spun-aluminum housing, with straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Wheel: Aluminum, forward curved, backward inclined or airfoil blades welded to aluminum hub.
- E. Direct-Drive Units: Motor encased in housing out of air stream, factory-wired to disconnect located on outside of fan housing.
- F. Accessories: Provide the following accessories as indicated:
 - 1. Volume Control Damper: Manual operated with quadrant lock, located in fan outlet.
 - 2. Companion Flanges: For inlet and outlet duct connections.
 - 3. Fan Guards: Expanded metal in removable frame.

4. Speed Control: Variable speed switch with on-off control and speed control for 100 to 50 percent of fan air delivery.
5. Motor sound attenuator.

PART 3 - EXECUTION

3.01 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of structural steel support members.

3.02 INSTALLATION

- A. Install fans level and plumb, in accordance with manufacturer's written instructions.
- B.
- C. Install vibration isolation for equipment as specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."
- D. Arrange installation to provide access space around fans for service and maintenance.

3.03 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust damper linkages for proper damper operation.
- B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.04 STARTUP

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
 1. Remove shipping blocking and bracing.
 2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 3. Perform cleaning and adjusting specified in this Section.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
 7. Disable automatic temperature control operators.
- B. Starting procedures for fans:
 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 - a. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Shut unit down and reconnect automatic temperature control operators.
 4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.05 DEMONSTRATION

- A. Demonstration Services: Train Owner's maintenance personnel on the following:
 - 1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
 - 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."
- B. Schedule training with at least 7 days' advance notice.

END OF SECTION 23 3423

SECTION 233600
AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Variable Air Volume Terminal Units
 - 1. Reheat

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished; certified sound power data for each unit; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components and electrical characteristics and connection requirements.
- C. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
- D. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.
- E. Nameplate Data: Nameplate data shall be submitted in a timely manner so as to allow proper coordination with the Electrical Contractor. Submittals that do not have nameplate data will be rejected.
- F. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- G. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.
- H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include this data, product data, shop drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 1.

1.03 QUALITY ASSURANCE

- A. ADC Compliance: Provide air terminals that have been tested and rated in accordance with ADC standards, and bear ADC Seal.
- B. AHRI Compliance:
 - 1. Provide air terminals that have been tested and rated in accordance with AHRI 880 "Performance Rating of Air Terminals" and bear AHRI certification seal.
 - 2. Provide air terminals that meet the scheduled sound performance in compliance with AHRI 885 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets".
- C. UL/ETL Compliance: Air terminal units shall be UL or ETL listed as a complete assembly. All electrical components shall be UL listed and installed in accordance with the National Electric Code.
- D. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.04 SPARE PARTS

- A. If HVAC equipment is used during construction, the contractor is fully responsible for it's cleaning just before substantial completion prior to testing and balancing.

PART 2 - PRODUCTS

2.01 VARIABLE AND CONSTANT AIR VOLUME TERMINAL UNITS

- A. Manufacturers:
 - 1. Carnes Co.
 - 2. Nailor Industries, Inc.
 - 3. Price Industries.
 - 4. Titus Products Div.; Philips Industries, Inc.
 - 5. Trane (The) Co.
- B. Construction
 - 1. Casings: Construct of galvanized sheet metal of minimum 22 gauge thickness or die-cast aluminum of minimum 20 gauge thickness.
 - a. Assembled with longitudinal lock seam construction.
 - b. Construct casings such that when subjected to 0.5-in w.g. pressure for low pressure units, and 3.0-in w.g. pressure for high pressure units, total leakage does not exceed 2% of specified air flow capacity with outlets sealed and inlets wide open.
 - 2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes or rectangular where needed to meet airflow requirements.
 - 3. Unit Discharge: Rectangular, with slip-and-drive connections.
 - 4. Acceptable Liners:
 - a. Linings: Line inside surfaces of casings with fiberglass, lining material to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing. Provide minimum thickness of 1/2". Secure lining to prevent delamination, sagging, or settling.
 - 5. Access: Provide removable panels in casings to permit access to air dampers, fans and other parts requiring service, adjusting, or maintenance.
 - a. Provide airtight gasket and quarter-turn latches.
 - 6. Provide hanger brackets for attachment of supports.
 - 7. Multiple Duct Connectors: For air terminals serving more than one air outlet, provide lined outlet plenum with duct collar, butterfly-type damper, and locking device in each outlet.
- C. Sound Attenuator
 - 1. Provide if required to meet scheduled acoustical performance requirements.
 - 2. Construction to consist of a continuous extension of the casing and liner as required to achieve required attenuation.
 - 3. At 2000 fpm inlet velocity, the additional differential pressure drop with attenuator not to exceed 0.2 inch wg.
 - 4. All sound data shall be compiled in an independent ADC certified laboratory and in accordance with the latest version of AHRI 880. All units shall be AHRI certified and bear the AHRI certification label.
- D. Primary Air Damper Assembly
 - 1. Heavy-gauge, galvanized steel or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.

2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
3. Incorporate low leak damper blades for tight airflow shutoff.
 - a. Air Leakage Past Closed Damper: Maximum two percent of unit maximum airflow at 3 inch wg inlet static pressure, tested in accordance with ASHRAE Std 130.
- E. Hot Water Heating Coil:
 1. Seamless copper tubes, mechanically expanded into aluminum or aluminum-plated fins.
 2. Include low-leakage access door for coil inspection and cleaning.
 3. Coil leak tested to minimum 200 psig.
 4. Base performance data on tests run in accordance with AHRI 410.
- F. Electrical Requirements:
 1. Single-point power connection.
 2. Equipment wiring to comply with requirements of NFPA 70.
 3. All electrical components shall be UL or ETL listed or recognized and installed in accordance with the National Electrical Code.
 4. All electrical components shall be mounted in a control box.
 5. The entire assembly shall be UL or ETL listed (cETL in Canada) and so labeled.
- G. Control Transformers: Factory supplied and mounted for electric and electronic control applications.
- H. Controls: Provide controls accurate to 1.5 degrees F and adjustable from 65 degrees F to 85 degrees F. Provide air flow measurement station at terminal unit inlet. Provide control type as indicated below.
 1. DDC (Direct Digital Control): Provide direct digital controls, compatible with direct digital control system specified in other Division 23 sections.
 - a. The unit level controller to include the following:
 - 1) 24 VAC power terminal or RJ-12 Power connection.
 - 2) Port for thermostat connection.
 - 3) Service Port for diagnostic equipment.
 - 4) Damper actuator.
 - 5) LED indication for troubleshooting.
 - 6) Heating output signal(s).
 - 7) Cooling output signal(s).
 - 8) Supply air temperature sensor input.
 - 9) Contact closure input.
 - 10) BACNET communication capability.
 - b. Include a factory-installed, unit-mounted direct-digital controller.
 - c. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
 - d. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.
 - 1) Occupied and unoccupied operating mode.
 - 2) Remote reset of temperature or CFM set points.
 - 3) Proportional, plus integral control of room temperature.
 - 4) Monitoring and adjusting with portable terminal.

- 5) Time-proportional reheat coil control.
- e. Room Sensor:
 - 1) Compatible with temperature controls specified.
 - 2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
- 2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
 - a. Sensor Requirements:
 - 1) Plastic parts shall be fire-resistant, complying with UL 94.
 - 2) Control tubing shall be protected by grommets at the wall of the air flow sensor's housing.
 - 3) Furnished with multiple total and static pressure sensing ports and a center averaging chamber that amplifies the sensed air flow signal.
 - 4) Provide sensor with a pressure transducer to interface with the building control system.
 - b. Signal accuracy: Provide accuracy within 5 percent throughout the terminal unit operating range.
- I. Identification: Provide label on each unit indicating Plan Number, cfm range, cfm factory-setting, and calibration curve (if required).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install the inlets of air terminal units and air flow sensors a minimum of three duct diameters from elbows, transitions, and duct takeoffs.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.

3.03 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to scheduled minimum flow.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, duct connections to air terminals, and water coils are leak-tight.
 - 1. Leak Test:
 - a. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.
 - b. Repair water leaks and retest until no leaks exist.
 - 2. Operational Test:
 - a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - b. Test and adjust controls and safeties.

- c. Replace damaged and malfunctioning controls and other equipment.

3.05 CLEANING

- A. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.
- B. Install new filters.

END OF SECTION 233600

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SECTION 23 3713
DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Ceiling air diffusers.
- B. Registers and grilles.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
 - 1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
 - 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details. Indicate selections on product data.
 - 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.
- D. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.
- E. Color Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

1.03 QUALITY ASSURANCE

- A. Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing the Performance of Air Outlets and Inlets".
- B. Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
- C. Provide air outlets and inlets bearing ADC Certified Rating Seal.
- D. Test and rate sound data for air outlets and inlets in accordance with AHRI 885 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets (with Addendum 1)".
- E. Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.04 SPARE PARTS

- A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

PART 2 - PRODUCTS

2.01 CEILING AIR DIFFUSERS

- A. Manufacturers
 - 1. Carnes Co.
 - 2. Greenheck.
 - 3. Krueger Mfg. Co.
 - 4. Metalaire; Metal Industries, Inc.
 - 5. Nailor Industries, Inc.
 - 6. Price Industries, Inc.
 - 7. Titus HVAC
 - 8. Tuttle & Bailey; Div. of Air Systems Components, Inc.
- B. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- C. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- D. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
- E. Types: Provide ceiling air diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.02 REGISTERS AND GRILLES

- A. Manufacturers
 - 1. Carnes Co.
 - 2. Greenheck.
 - 3. Krueger Mfg. Co.
 - 4. Metalaire; Metal Industries, Inc.
 - 5. Nailor Industries, Inc.
 - 6. Price Industries, Inc.
 - 7. Titus HVAC
 - 8. Tuttle & Bailey; Div. of Air Systems Components, Inc.
- B. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- C. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
- D. Ceiling Compatibility: Provide registers and grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of register and grille.
- E. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with

accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

- F. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.
- C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 section "Air Duct Accessories".
- D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

3.03 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

3.04 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

END OF SECTION 23 3713

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END OF SECTION 26 0000

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SECTION 26 0010
GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and to all following sections within Division 26.

1.02 SECTION INCLUDES

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. The Contractor will show the materials and their relationship to one another, including sizes, shapes, locations, and connections. The Contractor also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.03 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
 - 1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
 - 2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
 - 3. Provide: "To furnish and install complete, and ready for the intended use."
 - 4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division."
 - 5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division.

6. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is [the "Architect"] [the "Owner's Representative"] [the "Engineer"] [the "Construction Manager"] ["Henderson Building Solutions"].
7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.
9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. 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.
 - b. 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.
10. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
11. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified
- B. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
- C. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- D. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 3. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference, unless otherwise noted.

1.04 REFERENCE STANDARDS

- A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between

various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

IBC	International Building Code
ADA	Americans with Disabilities Act
AEIC	Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
ICEA	Insulated Conductors Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code, NFPA 70
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers' Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
UL	Underwriter's Laboratories

- E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.
- G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.

- C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.
- D. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- E. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes installed.
- F. 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.
- G. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

1.06 MEASUREMENTS AND LAYOUTS:

- A. The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.07 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of 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 trade.
 - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
 - 4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - 5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
 - 6. Indicate required installation sequence to minimize conflicts between entities.
 - 7. 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 Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
 1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
 2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
 3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
 4. Include work provided by others routed through the equipment rooms.

1.08 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.

- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

1.09 SUBSTITUTIONS

Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

- A. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- B. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, Construction Manager, and Owner, the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- C. Substitution Consideration:
 - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. Prior to receipt of Bids: No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
 - a. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
3. After receipt of Bids: No substitutions will be considered after receipt of Bids and before award of the Contract.
4. After award of Contract: No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.
- C. Contact the Contract Administrator for written authorization.
- D. The following must be received before electronic drawing files will be sent:
 1. Contract Administrator's written authorization
 2. Engineer's release agreement form
 3. Payment

1.11 QUALITY ASSURANCE

- A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.
- B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish the Operation and Maintenance Manuals to the Contract Administrator, for Engineer's review, and for the Owner's use.

1. Refer to Division 01 for acceptance of electronic manuals for this project. If not specified in Division 1, provide manuals in the form of a multiple file composite electronic PDF file for each manual type required. Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size. Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
 - a. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.
 2. If Division 01 requires paper manuals, provide four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

1.13 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division

1.14 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.15 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or

damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

- D. Be responsible for the safe storage of tools, material and equipment.

1.16 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.
- D. Also warrant the following additional items:
 - 1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
 - 2. All raceway seals are effective.
 - 3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.
- E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
 - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
 - 2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

- a. Vent and exhaust fuel-burning heaters per SMACNA Guidelines for Source Control and equip units with individual-space thermostatic controls.
- b. If permanent HVAC systems are used during construction, provide HVAC Protection and replace all filtration prior to occupancy in accordance with SMACNA Guidelines.

1.18 FIELD CONDITIONS

- A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:
 1. The Drawings describe the general nature of remodeling to the existing building; however, visit the site prior to submitting bid to determine the nature and extent of work involved.
 2. Schedule work in the existing building with the Owner.
 3. Perform certain demolition work prior to the remodeling. Perform the demolition that involves electrical systems, Light fixtures, equipment, raceways, equipment supports or foundations and materials.
 4. Remove articles that are not required for the new work. Unless otherwise indicated, remove each item removed during this demolition from the premises and dispose in accordance with applicable federal, state and local regulations.
 5. Relocate and reconnect electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical equipment or materials are removed, cap unused raceways below the floor line or behind the wall line to facilitate restoration of finish.
 6. Finish material will be installed under other divisions.
 7. Obtain permission from the Contract Administrator for roof penetrations and channeling of floors or walls not specifically noted on the Drawings.
 8. Protect adjacent materials indicated to remain. For work specific to this Division, install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 9. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, provide temporary services for affected areas.
- B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- C. Use of explosives is not permitted [, unless otherwise specified or allowed for powder-actuated tools].
- D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - EXECUTION

2.01 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.

2.02 EXISTING CONDITIONS

- A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new work.
- B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

- C. Notify Contract Administrator immediately of any dangerous conditions that exist on the job site, as they are discovered, before demolition, during selective demolition or before remodel work begins.

2.03 EXISTING UTILITIES

- A. Prepare and submit a schedule of anticipated utility outages indicating dates and duration. Schedule
- B. Schedule and coordinate with the utility companies, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal utility services from any existing utility line. Include all premium time required for all such work in the bid.
- C. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or utility companies without additional cost.
- D. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.
- E. Make repairs and restoration of utilities before workers leave the project at the end of the workday in which the interruption takes place.
- F. Include in bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

2.04 WORK IN EXISTING FACILITIES

- A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the site prior to submitting a bid, to determine the nature and extent of work involved.
- B. Schedule work in the existing facility with the Owner.
- C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves electrical systems, fixtures, conduit, wiring, equipment, equipment supports or foundations and materials.
- D. Remove all of these articles that are not required for the new work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.
- E. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner, or others, unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.
 - 3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
 - 4. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.
- F. Relocate and reconnect all electrical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where electrical fixtures or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.
- G. Finish materials are specified in other divisions.
- H. Where removal of existing wiring interrupts electrical continuity of circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued electrical continuity.

- I. Penetrate roofs, channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all penetrations and channeling not specifically noted on the Drawings.
- J. Provide new, typewritten card directory for distribution equipment (including but not limited to load centers, panelboards, switchboards and switchgear) where changes occur under this scope of work. Indicate exact loads served by each existing circuit breaker or switch. Where circuit designations are not specifically indicated on the Drawings, provide a unique identifier for each updated circuit within the directory.
- K. Coordinate work with Architectural phasing drawings to properly stage transitions of work to provide power to existing, new and temporary loads. Monitor loads on distribution system to ensure shifting of loads does not overload electrical equipment.
- L. Work in common areas, shafts or other Owner owned and/or operated spaces must be reviewed and approved by the Contract Administrator and Owner prior to commencement of the work.
 - 1. Contractor shall minimize any disruption and disturbances to other tenants. All work within other tenant spaces must be coordinated with and approved by the Landlord and Owner.

2.05 PERMITS

- A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

2.06 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.
- B. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment To Be Salvaged: remove, demount, disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- E. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
 - a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 26.

2.07 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

2.08 PENETRATIONS

- A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

2.09 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.
- C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.
- D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.
- E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.
- F. Slope sides of excavations to comply with local, state, and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state, and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within dripline of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Excavation for Underground Tanks and Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches for electrical installations as follows:
1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
 2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
 5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.
- M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. Other areas use excavated or borrowed materials.
- O. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry

density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
 - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 - 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

2.10 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

2.11 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.
- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

2.12 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Electrical Contractor shall clean material and equipment installed under the Electrical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment.
- C. Damaged finishes shall be touched-up and restored to their original condition

2.13 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.
- B. Check motors for alignment with drive and proper rotation, and adjust as required.
- C. Check and test protective devices for specified and required application, and adjust as required.
- D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.
- E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.
- G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.
- H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.
- J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.
- K. Refer to individual sections for additional and specific requirements.

2.14 START-UP OF SYSTEMS

- A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.
- B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.
- C. Adjust taps on each transformer for rated secondary voltages.
- D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.

- E. Replace all burned-out lamps. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Owner.
- F. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.
- G. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- H. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

2.15 TEST REPORTS

- A. Perform tests as required by these Specifications and submit the results to the Contract Administrator, for Engineer's review. Record the results, date and time of each test and the conditions under which the test was conducted. Include a copy of the finalized test results, with corrections made, in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.
- B. For specific testing requirements of special systems, refer to the Specification section that describes that system. The Contractor shall provide the following to facilitate the testing of the electrical systems:
 - 1. Perform tests as described in the individual sections;
 - 2. Engage the services of a 3rd Party testing agency to perform tests as noted below, or;
 - a. Agent may be an employee of the contractor but shall be NETA certified to perform electrical testing.
- C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:
 - 1. Building service entrance voltage and amperes at each phase.
 - 2. Electrical service grounding conditions and grounding resistance.
 - 3. Proper phasing throughout the entire system.
 - 4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
 - 5. Phase voltages and amperes at each three-phase motor.
 - 6. Test all wiring devices for electrical continuity and proper polarity of connections.
- D. Promptly correct all failures or deficiencies revealed by these tests in accordance with the manufacturer's recommendations and as determined by the Engineer.

2.16 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 - 1. Submit complete Operation and Maintenance Data.
 - 2. Submit complete Record Drawings.
 - 3. Perform all required training of Owner's personnel.
 - 4. Turn over video recordings of training sessions to the Owner.
 - 5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.

6. Perform start-up tests of all systems.
 7. Remove all temporary facilities from the site.
 8. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.
- B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days' notice prior to the review.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items the Contractor shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 26 0010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples
☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

Similar Installation: _____

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No	
Additional Comments:	☐ Attached	☐ None	

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:
1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
 2. Sleeves and seals for electrical penetrations.
 3. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 4. Sealing penetrations through noise critical spaces.

DEFINITIONS

- B. The following abbreviations apply to this and other Sections of these Specifications:
1. AHJ: Authority(ies) having Jurisdiction
 2. ATS: Acceptance Testing Specifications
 3. EPDM: Ethylene-propylene-diene monomer rubber
 4. MC: Metal Clad
 5. N/A: Not Available or Not Applicable
 6. NBR: Acrylonitrile-butadiene rubber
 7. NRTL: Nationally Recognized Testing Laboratory
 8. PCF: Pounds per Cubic Foot
 9. STC: Sound Transmission Class
- C. The following definitions apply to this and other Sections of these Specifications:
1. Homerun: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
 4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
- E. Coordinate with general contractor to provide at least one path to outside with 8'-0" tall door in main electrical rooms and generator rooms that contain switchgear, motor control centers, generators and other electrical equipment taller than 6'-6".

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Sleeve seals.
 - b. Through and membrane penetration firestopping systems.
 - c. Joint sealers
 - d. Acoustical sealers
 - e. Endothermic wrap
 - 2. Shop drawings for:
 - a. Detailed fabrication drawings of access panels and doors.
 - 3. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to qualified testing and inspecting agency's illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
 - b. Qualifications data for testing agency.
 - 4. Endothermic Wrap drawings and system details: Provide UL listing, assembly rating and installation drawing for each case specific installation. Include installation instructions indicating layers of wrap required and securing method.
 - a. Where Project conditions require modifications to qualified testing and inspecting agency's installation requirements for a particular listed fire rated electrical circuit protective system, submit illustration with modifications marked and approved by Endothermic Wrap manufacturer's fire protection engineer as an engineering judgement or equivalent fire-resistive-rated assembly.
 - 5. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26
 - a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

1.04 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.
 - 1. Offices
 - 2. Conference Rooms
 - 3. Teleconference Rooms
 - 4. Meeting/Banquet Rooms
 - 5. Sound/Lighting Control Rooms

6. TV Production Studio
7. Stage
8. A/V Spaces
9. Choir Risers
10. Drama Theatres
11. Music Teaching Studios
12. Sanctuary
13. Patient Care Areas
14. Procedure Spaces
15. Exam Rooms
16. Consultation Rooms
17. Operating Rooms
18. Courtrooms
19. <Insert others as required>

PART 2 - PRODUCTS AND MATERIALS

2.01 ACCESS TO EQUIPMENT

A. [Available]Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Electrical Systems" for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Contract Administrator prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.

- b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
- 7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
- 8. Locking Devices:
 - a. Flush, screwdriver-operated cam locks.
 - b. Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, [individually keyed][all access panels keyed alike]; provide 2 keys per access panel.

2.02 SLEEVES

- A. Steel sleeves for raceways and cables:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.
- B. Cast iron wall pipe sleeves for raceways and cables:
 - 1. Manufacturers
 - a. Josam Mfg. Co.
 - b. Smith (Jay R) Mfg. Co.
 - c. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
 - d. Watts Industries, Inc.
 - e. Zurn Industries, Inc.; Hydromechanics Div.
 - 2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with setscrews.
 - 3. Sleeves for rectangular openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
 - 4. Coordinate sleeve selection and application with selection and application of firestopping to be used.

2.03 SEALANTS

- A. SLEEVE SEALS
 - 1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 2. [Available] Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. O-Z/Gedney
 - e. Pipeline Seal and Insulator, Inc.
 - 3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.

- a. EPDM
 - b. NBR
 - c. Neoprene
 4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.
 - a. Plastic
 - b. Carbon steel
 - c. Stainless steel
 - d. PVC-coated steel
 5. Connecting Bolts and Nuts: Provide bolts of length required to secure pressure plates to sealing elements. Include one for each sealing element.
 - a. Carbon steel with corrosion-resistant coating
 - b. Stainless steel
- B. JOINT SEALERS
1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
 2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.
 3. Elastomeric Joint Sealers: Provide the following types:
 - a. Silicone Joint Sealants, One-part nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
 - 1) Dow Corning, Dowsil 790
 - 2) Dow Corning, Dowsil 795
 - 3) GE, Silglaze II SCS 2350
 - 4) GE, Silpruf SCS 2000
 - 5) Owens Corning, Energy Complete
 - 6) Pecora, 864 NST
 - 7) Tremco, Spectrem 1
 - 8) Tremco, Spectrem 2
 - b. Mildew Resistant Sealants, one-part mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
 - 1) Dow Corning, Dowsil 786
 - 2) GE, Momentum SCS 1700
 - 3) Pecora, 898 Silicone NST
 - c. Hybrid Joint Sealants: One-part, nonsag, paintable complying with ASTM C 920, Type S, Grade NS, Class 50 recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent. Subject to compliance with requirements, provide one of the following:

- 1) BASF, MasterSeal NP 100
- 2) Pecora, DyanTrol I-XL
- 3) Tremco, Dymonic FC

C. FIRESTOPPING

1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ. Subject to compliance with requirements, provide one of the following:
 - a. [Available]Manufacturer[s]:
 - 1) 3M Corp., Fire Barrier Sealant
 - 2) Hilti, Inc.
 - 3) Tremco, Tremstop Fyre-Sil
 - 4) Pecora, AC-20 FTR
 - 5) RectorSeal
 - 6) Specified Technologies Inc. Firestop
 - 7) USG, SHEETROCK Firecode Compound
 - 8) Owens Corning Firestopping Insulation

D. ACOUSTICAL SEALANTS

1. General: Penetrations by conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
2. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.
3. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening, permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
4. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m3).
5. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining 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. Meeting ASTM E 84 for a smoke flame spread index of less than 25 / 50. Subject to compliance with requirements, provide one of the following:
 - a. Pecora, AC-20 FTR
 - b. Pecora, AIS-919
 - c. USG, SHEETROCK Acoustical Sealant.

2.04 FIRE RATED PROTECTIVE WRAPS

A. Endothermic Wrap

1. General: Protective wrap, designed to provide fire protection of critical feeders and circuits in accordance with ASTM E1725. Subject to compliance with requirements, provide one of the following:
 - a. 3M Corp., Interam Endothermic Mat
 - b. Specified Technologies Inc., E-Wrap

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- C. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)
- D. Comply with NECA 1.
- E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.
- F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- H. Right of Way: Yield to raceways and piping systems installed at a required slope.

3.02 ACCESS DOORS

- A. Verify the exact location, sizes, and types of all access doors with the Contract Administrator prior to purchase.
- B. Provide access doors for all concealed electrical equipment, except where above lay-in ceilings.
- C. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- D. Adjust hardware and panels after installation for proper operation.
- E. Label all access doors with a nameplate as described in Division 26 Section "Identification for Electrical Systems".

3.03 SLEEVES AND SLEEVE SEALS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Provide sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical work that passes through such construction. Coordinate with all other trades and divisions to dimension and lay out all such openings.
- C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other divisions.
- D. New Construction:
 - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support raceway penetrations.
- E. Construction in Existing Facilities:
 - 1. Saw cut or core drill existing walls, roofs and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls, roofs or slabs without first coordinating with, and receiving approval from, the Contract Administrator, Owner, or both. Seal sleeves into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Contract Administrator. Provide roofing penetration seals and covers to match existing roofing materials. Coordinate roofing repair of adjacent roofing material with Owner's roofing contractor to provide a waterproof installation.

- F. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.
- G. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- H. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- I. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- J. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.
- K. Sleeve Length:
 - 1. Sleeves through walls: Cut sleeves to length for mounting flush with both surfaces of walls.
 - 2. Sleeves through floors: Extend sleeves 2 inches above finished floor level.
- L. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed[or as required to meet seismic criteria]; in which case, size sleeves as recommended by the seal manufacturer[or per seismic criteria, or both].
- M. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- N. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint
- O. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.
- P. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- Q. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- R. Above Grade Concrete or Masonry Penetrations
 - 1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
 - a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
 - b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.
 - c. Install galvanized sheet metal for rectangular sleeves
 - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
 - 2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2" of sealant.

- S. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between sleeve and cable or raceway. Provide mechanical sleeve seal.
 - 1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - 2. Inspect installed sleeve and sleeve-seal installation for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.
- T. Concrete Slab on Grade Penetrations:
 - 1. Provide ½" thick cellular foam insulation around perimeter of raceway passing through concrete foundation. Installation shall extend to 2" above and below the concrete slab.
- U. Elevated Floor Penetrations of waterproof membrane:
 - 1. Provide cast-iron wall pipes for sleeves. Size wall pipe for minimum ½" annular space between wall pipe and cable or raceway.
 - 2. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.
 - 3. Secure waterproof membrane flashing between clamping flange and clamping ring.
 - 4. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.
- V. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.
- W. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.
- X. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.
- Y. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- Z. Sleeve-Seal Installation
 - 1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.
 - 2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- AA. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.
- BB. Sleeves shall be protected throughout the course of construction, and when damaged shall be replace and/or repaired to a satisfactory condition.

3.04 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly. [Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."]

3.05 JOINT SEALERS

- A. Preparation for Joint Sealers
 - 1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.
 - 2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.
- B. Application of Joint Sealers
 - 1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
 - 2. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.06 ACOUSTICAL PENETRATIONS

- A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.
- B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it. After all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

3.07 FIRE RATED PROTECTIVE WRAP

- A. Where indicated on the Drawings or required by code, provide fire rated protective wrap around raceways and equipment.
- B. Install and secure fire protective wrap per manufacturer's written installation documents. Wrap shall be layered as required by the manufacturer to provide 1-, 2-, or 3-hour fire rating required by code for the application.

END OF SECTION 26 0500

SECTION 26 0502
EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes limited scope for electrical connections to equipment specified under other sections or divisions, or furnished under separate contracts or by the Owner.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this contract.
- A. Coordinate with work described in Division 11 Sections for equipment requiring electrical connection.
- B. Coordinate with work described in Division 23 Section "Common Work Results for HVAC".
- C. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- D. Determine connection locations and rough-in requirements based on shop drawings.
- E. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- F. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products for:
 - 1. Special connectors
 - 2. Special conductors or cable assemblies.
- C. Shop drawings for:
 - 3. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 4. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.
 - 5. Marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.01 CORDS AND CAPS

- A. Attachment Plugs: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.

- C. Cord: See Paragraph "Flexible Cords" in Division 26 Section "Low-voltage Electrical Power Conductors and Cables".
- D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

1.2 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.
- C. Provide fire-resistive protective assembly or an electrical circuit protective system for feeders and control circuit conductors and cables having a fire-resistance rating of not less than 2 hours where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:
 - 1. Feeders for Emergency Power systems
 - 2. Smokeproof Enclosure Pressurization systems
 - 3. Smoke Removal systems
 - 4. Fire service and Occupant Evacuation Elevator systems

3.02 ELECTRICAL DEVICES

- A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) as indicated, specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.03 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturers' instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.
- C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.04 EQUIPMENT

- A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.
- D. Motorized Damper: Provide lockable toggle, pilot lighted disconnect switch in an accessible location at each motor actuator, or group of motor actuators.

3.05 FOOD SERVICE (SERVERY) EQUIPMENT

- A. Provide power connection to all equipment as indicated or as otherwise required to accommodate the equipment indicated in the food service equipment drawings and specifications.
- B. Coordinate and provide the appropriate receptacle for equipment being installed as required for proper operation. Coordinate the required quantity of conductors prior to pulling wire to outlet box.
- C. Provide a local recessed non-fused equipment disconnect for kitchen equipment as required by the applicable codes and jurisdictions. Coordinate exact location prior to rough-in and maintain all code required clearances.
- D. Provide control wiring and conduit for all equipment that is not indicated as being within the responsibility of the equipment manufacturer or installer.
- E. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, shall be provided by the equipment installer, unless otherwise noted.
- F. Coolers and Freezers: Cut conduit openings in freezer and cooler walls, floor, and ceilings, in accordance with manufacturers' instructions, when openings are not provided by the manufacturers. Seal around conduit penetrations air tight with an approved pliable material suitable for low temperatures. Effectively seal interiors of conduits, by installing a conduit fitting at the boundary of the two spaces, and filling it with an approved pliable material, after conductors or cables have been installed and tested.
- G. Provide all grounding systems as required by the equipment supplier.

3.06 DOOR OPERATORS AND HARDWARE

- A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors, and all other required electrical connections for door systems included in other sections of these specifications.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.
- D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with the NFPA codes.

3.07 SIGNAGE AND WAYFINDING

- A. Provide junction boxes, disconnect switches and grounding per manufacturer's installation drawings.
- B. Coordinate rough-in requirements with signage installation instructions.
- C. Coordinate box locations and conduit routing with parapets and roof elevations.
- D. Provide labelling on all junction boxes and disconnects in accordance with Division 26 section "Identification for Electrical Systems"

3.08 MEDICAL GAS SYSTEMS

- A. All connections associated with the medical gas system shall be made in accordance with NFPA 99 - Standard for Healthcare Facilities.
- B. Provide power connection to all equipment as indicated or as otherwise required to accommodate the equipment indicated in the medical gas system drawings and specifications.

- C. Provide all raceways, conduit, back boxes and cabling for all control wiring required to accommodate the equipment indicated in the medical gas system drawings and specifications, that is not indicated as being within the responsibility of the equipment installer.
- D. Provide all grounding systems as required by the equipment supplier.

3.09 MEDICAL EQUIPMENT

- A. Provide all work related to Division 26 required for the Owner furnished medical equipment. Note that this work has not been entirely duplicated and indicated on the sheets with E prefixes, rather only a minimum amount as required for coordination with other systems, and as required to comply with local codes. The medical equipment planner has prepared a complete manual including all the equipment intended to be purchased general electrical requirements and associated cut sheets. Review the medical equipment manual prior to bid. Prior to rough-in and final connection coordinate with final equipment installation diagrams, drawings, manuals, and specifications. Such equipment may include but shall not be limited to the following: mobile x-ray equipment, surgical or exam lights, articulating arms, equipment booms, headwalls, patient beds, patient lift systems, processors, sterilizers, warming cabinets, refrigerators, freezers, blood bank equipment, laboratory equipment, x-ray film view boxes, digital x-ray viewing systems, or bio-medical patient monitoring systems.
- B. Provide power connection to all equipment as indicated or as otherwise required to accommodate the medical equipment.
- C. Provide all grounding systems as required by the equipment supplier.
- D. Provide wireways, cable trays, trench duct, wall duct, conduit and all other raceways and boxes as required to accommodate the medical equipment that is not indicated as being within the responsibility of the equipment installer.
- E. Provide all other equipment, wiring, connections, emergency power off stations, warning lights, interlocks, controls, etc. as required to accommodate the medical equipment that is not indicated as being within the responsibility of the equipment installer.

3.10 DIAGNOSTIC AND THERAPEUTIC MEDICAL IMAGING EQUIPMENT

- A. Provide all work related to Division 26 required in the medical equipment installation drawings. Note that this work has not been entirely duplicated and indicated on the sheets with E prefixes, rather only a minimum amount as required for coordination with other systems, and as required to comply with local codes. Typically the medical equipment installation drawings are attached to the construction drawing set, however some vendors issue a separate installation manual in book format. Review all medical equipment installation drawings, manuals, and specifications prior to bid and rough-in. Such equipment may include but shall not be limited to the following: x-ray equipment, catheterization lab equipment, linear accelerator equipment, simulator equipment, CT scan equipment, MRI equipment, surgical room lights and equipment, and other diagnostic and therapeutic equipment.
- B. Provide power connection to all equipment as indicated or as otherwise required to accommodate the medical equipment.
- C. Provide all grounding systems as required by the equipment supplier.
- D. Provide wireways, cable trays, trench duct, wall duct, conduit and all other raceways and boxes as required to accommodate the medical equipment that is not indicated as being within the responsibility of the equipment installer.
- E. Provide all other equipment, wiring, connections, emergency power off stations, warning lights, interlocks, controls, etc. as required to accommodate the medical equipment that is not indicated as being within the responsibility of the equipment installer.

END OF SECTION 26 0502

SECTION 26 0510
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements as follows:
 - 1. Pathways for Communications Systems
 - a. Conduits and Backboxes
 - b. Floor Boxes and Poke Throughs
 - c. Cable Trays
 - d. Access doors
 - e. Fire Stop System Assemblies for Communications Systems
 - f. Sleeves entering noise critical spaces
 - 2. Telecommunications Backboards
 - 3. Grounding and Bonding for Communications Systems

1.02 DEFINITIONS

- A. Backbone Bonding Conductor (BBC) – The conductor that interconnects elements of the telecommunications grounding infrastructure.
- B. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, and potentially other low-voltage systems such as audio-visual, security and fire alarm (electronic safety and security) equipment. Also known as Telecommunications Room, Telecom Room, IT Room, MDF, or IDF.
- C. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- D. IDF – Intermediate Distribution Frame, secondary Communications Room(s) for a building
- E. IMC – Intermediate Metal Conduit
- F. MDF – Main Distribution Frame, the Main Communications Room for a building
- G. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn't identified on the drawings, assume the Main Communications Room (MDF) also acts as the Point of Entrance.
- H. Primary Bonding Busbar (PBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.
- I. RCDD – Registered Communications Distribution Designer as certified by BICSI
- J. RMC – Rigid Metal Conduit
- K. Secondary Bonding Busbar (SBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.
- L. STC – Sound Transmission Class, a single number decibel rating of the transmission loss properties of an assembly. Measured transmission loss data is plotted versus frequency and compared with standard contours according to rules outlined in ASTM E 90 and ASTM E 413.

- M. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).
- N. Telecommunications Bonding Conductor (TBC) – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

1.03 REFERENCE STANDARDS

- A. The references to the following standards and guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON).
 - 1. TIA-569 – “Telecommunications Pathways and Spaces”
 - 2. TIA-607 – “Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises”
 - 3. ANSI/NECA/BICSI 607-2011 – Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - 4. BICSI Telecommunications Distribution Methods Manual (TDMM)
 - 5. [NEMA VE 1 – “Metallic Cable Tray Systems”
 - 6. NEMA VE 2 – “Cable Tray Installation Guidelines”]
 - 7. [ASTM E 814 and ANSI/UL1479 –“Fire Tests Through Penetration Firestops”
 - 8. ASTM E 84 and ANSI/UL 723 “Surface Burning Characteristics of Building Materials”
 - 9. ASTM E 119 and ANSI/UL 263 “Fire Tests of Building Construction Materials”]

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate arrangement, mounting, and support of communications equipment with Telecommunications equipment furnished by Owner and Telecommunications service providers.
- B. Coordinate arrangement, mounting, and support of communications equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
 - 3. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
- C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- D. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.
- E. Coordinate testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.05 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:
 - 1. Product data for the following products:
 - a. Floor Boxes and Poke Throughs
 - b. Cable Trays
 - c. [Fire Stop Materials and Systems
 - 1) Documentation from UL catalog for each system proposed. This documentation shall include the following information:

- a) Firestop manufacturer
 - b) UL system number
 - c) F, T, and L Ratings
 - d) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.]
- d. Telecommunications ground bars and connectors
- 2. Shop Drawings for:
 - a. Submit for review scaled layout drawings showing the routing of all pathways and firestop locations (with quantity and NRTL system number identified), Each pathway shall be identified by type and size on the drawings
 - b. Unless otherwise required by these specifications, it is permissible to show different pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop drawing.
- 3. Record Documents:
 - a. Resubmittal of approved product submittals, with installation and O&M manuals.
 - b. Floor plans shall show the routing of all pathways and firestop locations (with quantity and NRTL system number identified) as actually installed. Each pathway shall be identified by type and size on the drawings.
 - c. Letter stating that the Telecommunications Grounding and Bonding System has been installed in accordance with the referenced standards and contract documents, including testing requirements.

1.06 QUALITY ASSURANCE

- A. All cable supports shall be manufactured by a company which produces cable supports. No field made apparatus will be accepted without prior written approval.

1.07 NOISE CRITICAL SPACES

- A. For Noise –critical spaces, provide Acoustic Pathway Devices as needed and attenuating measures and acoustical sealants as indicated in Division 26, “ Common Work Results for Electrical”.

PART 2 - PRODUCTS AND MATERIALS

2.01 PATHWAYS FOR COMMUNICATIONS SYSTEMS

- A. Raceways and Boxes for Communications Systems
 - 1. General Requirements
 - a. Refer to Division 26, “Raceways and Boxes for Electrical Systems” for Available Manufacturers and other specific product, material and installation requirements.
 - b. Outlet boxes located in plenum accessible ceiling space shall be listed for installation in a plenum.
 - c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the following paragraphs. Manufacturers and model numbers listed are used only to represent the characteristics required and are not intended to restrict the use of other Available Manufacturers models that meet the specified criteria.

2. Back boxes for Telecommunications Systems (Telephone, Data, and Multi-Service Outlets) installed in stud walls:
 - a. Requirements:
 - 1) Minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth
 - 2) with a single-gang raised cover/extension ring a minimum of 3/8" deep. Depth shall match that of wall gypsum board(s)
 - b. Manufacturers:
 - 1) Emerson/Appleton
 - 2) Hubbell RACO
 - 3) Randl
 - 4) ABB/Thomas & Betts/Steel City
 3. Back boxes for Telecommunications Systems (Telephone, Data, and Multi-Service Outlets) installed in masonry construction:
 - a. Requirements:
 - 1) Minimum size shall be singlegang, a minimum of 3-1/2 inches deep.
 - b. Manufacturers:
 - 1) Emerson/Appleton
 - 2) Hubbell RACO
 - 3) Randl
 - 4) ABB/Thomas & Betts/Steel City
 4. Back boxes for Audio Visual outlets
 - a. Refer to AV drawings and specifications for exact requirements. When there are no AV drawings/specifications, meet the requirements of this section:
 - b. Requirements
 - 1) Dual-gang
 - 2) Depth shall be 3-1/2 inches minimum.
 - c. Manufacturers:
 - 1) Hubbell RACO
 - 2) FSR, Inc.
 - 3) Legrand
 5. Pull Boxes
 - a. Refer to Boxes, Enclosures and Cabinets section of Division 26 "Raceways and Boxes for Electrical Systems".
- B. Cable Tray
1. Flexible cable tray
 - a. Manufactures:
 - 1) Atkore/Cope
 - 2) Bettermann Group/Chalfant
 - 3) Chatsworth
 - 4) Eaton/Cooper B-Line
 - 5) Hubbell

- 6) Legrand/Cablofil
- 7) MPHusky
- 8) nVent/Hoffman
- 9) Schneider Electric/WIBE
- 10) Snake Tray
- 11) Thomas & Betts
- 12) WBT LLC

b. Specifications

- 1) Cable Tray Size: Size identified on drawings indicate minimum width and depth size. Provide cable tray of sufficient size to accommodate a maximum calculated fill ratio of 50% for all Division 27 and 28 cabling, to include all cables installed plus 25% growth.
- 2) Cable tray systems shall be pre-fabricated structures for supporting and routing cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system.
- 3) Flexible cable tray systems shall consist of straight sections, fittings, and accessories as necessary for a complete, continuously grounded system.
- 4) Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
- 5) Cable Tray Materials: Steel rod and/or wire; corrosion resistant to the degree suitable for the environment where it is to be installed; field-bendable.
- 6) Cable Tray Types:
 - a) Wire cable tray: a cable tray manufactured from metal wire welded at all intersections and is formed to provide a channel for the cables.

2. Rigid Cable Tray

a. Manufacturer:

- 1) Atkore/Cope
- 2) Chalfant
- 3) Eaton/Cooper B-Line
- 4) Legrand/Cablofil
- 5) MonoSystems
- 6) MPHusky
- 7) Schneider Electric/WIBE
- 8) Snake Tray
- 9) Thomas & Betts

b. Specifications

- 1) Refer to Electrical Division 26 for specific product and material information.
 - a) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
- 2) Cable Tray Size: Provide cable tray with the loading depth and loading width as shown on the drawings.

- 3) Cable tray systems shall be pre-fabricated structures for supporting and routing cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system.
 - 4) Cable trays shall be designed to accommodate a maximum calculated fill ratio of 50%, to include all cables installed with 25% growth.
 - 5) Overhead Supports:
 - a) The support span for cable support systems shall be determined in accordance with the manufacturer's maximum recommended load capacity for a given span. These systems may be supported by three basic methods: cantilever brackets from a wall, trapeze or individual rod supports from the ceiling, or directly from the floor.
 - b) Cable tray supports shall be located where practicable so that connections between sections of the tray fall between the support point and $\frac{1}{4}$ the distance of the span. A support should be placed within 24 inches (609.6 mm) on each side of any connection to a bend, tee, or cross. See the NEMA-VE2 Metal Cable Tray Installation Guidelines for additional cable tray support and installation recommendations.
 - 6) Cable tray systems shall consist of straight sections, fittings, and accessories as defined in NEMA VE-1 and UL classified as equipment grounding conductors. Provide radiused elbows, tees, crosses, splice plates, wall and overhead supports, and other fittings necessary for a complete, continuously grounded system.
 - a) Fittings and connectors shall be used to connect straight sections and change direction or size. Fittings include horizontal bends, vertical bends, reducers, crosses and tees. Connectors may include splice plates, splice clamps, and tee clamps. Accessories may include such items as covers, conduit adapters and barriers.
- C. Access Doors for Communications Systems
1. Refer to Execution section for location requirements.
 2. Refer to Division 26, "Common Work Results for Electrical" for specific product and material information.
- D. Fire stop System Assemblies for Communications Systems
1. General
 - a. Communications cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple Fire-Rated Pathway Devices for Communications (capacity shall match that of cable tray cross-sectional area), and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.
 - b. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
 2. Fire-Rated Pathway Device for Communications - for sleeves through a single penetration (wall or floor)
 - a. Allows the installation and removal of cables without the need to remove or add any materials.
 - b. Used to seal penetrations of cables through fire rated partitions.

- c. Manufacturer shall be:
 - 1) EZ-Path family of products by Specified Technologies Inc.
 - 2) Wiremold Flamestopper
 - 3) Or equivalent from Conditionally Approved manufacturer.
- 3. Firestopping for Communications Backboxes in Fire-Rated Walls
 - a. Specifications
 - 1) Used to seal communications backboxes in fire rated partitions.
 - 2) Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
 - 3) Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - b. Manufacturer shall be:
 - 1) Specified Technologies Inc., SpecSeal Power Shield
 - 2) Or equivalent from
 - a) 3M
 - b) Hilti
- 4. Firestopping for Thru-Wall (or Floor) Communications Conduit Penetrations and Other Applications
 - a. For fire-rated penetrations where the pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications required by Communications Pathways not previously addressed in this specification.
 - b. Specifications:
 - 1) Shall be UL listed for the specific application;
 - 2) Shall meet or exceed the ratings of the wall or floor that it penetrates.
 - c. Manufacturer shall be:
 - 1) Specified Technologies Inc., SpecSeal Power Shield
 - 2) Or equivalent from
 - a) 3M
 - b) Hilti
- E. Sleeves Entering Noise Critical Spaces – Acoustic Pathway Device
 - 1. Where walls or ceiling-mounted Communications Devices are located inside Noise Critical Spaces, and/or for Communications System sleeves through acoustically-rated (non-fire-rated) walls at or above STC-50, provide Acoustic Pathway Device(s) to support low-voltage telecommunications/AV/security cabling.
 - 2. Specifications:
 - a. Shall maintain STC Rating of the penetrated wall.
 - b. Shall accommodate cable loads from 0 to 100% visual fill.
 - c. Shall be zero-maintenance, meaning no action is required by cabling technician to open/close pathway for cable moves, adds, or changes.
 - d. Shall be engineered such that cables can
 - e. Where more than one Acoustic Pathway Device is needed, they shall be ganged together with manufacturer supplied grid.

3. Manufacturer shall be:
 - a. Specified Technologies EZ-Path Smoke & Acoustical Pathway (NEZ33)

2.02 BONDING AND GROUNDING (EARTHING)

A. General

1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the ANSI/TIA-607 Standard "Generic Telecommunications Bonding and Grounding for Customer Premises". Major components include:
 - a. PBB in the Entrance Facility and SBBs in all remaining Telecommunication Rooms and Spaces.
 - b. TBC connecting the PBB to the main Electrical Service Ground.
 - c. TBB connecting the PBB to all SBBs.
 - d. All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the referenced standard.
2. Available Component Manufacturer[s]:
 - a. Chatsworth
 - b. Cooper B-Line
 - c. Erico
 - d. Harger
 - e. Hoffman
 - f. Panduit
3. Conductor Manufacturers
 - a. Shall be from the list of Component Manufacturers; or
 - b. Shall be from the list of Manufacturers in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

B. Primary Bonding Busbar (PBB)

1. Specifications
 - a. All busbars shall have a clear cover installed to protect connections
 - b. Cover shall be:
 - 1) Plexiglass or plastic
 - 2) Cover shall be printed with 3/8" lettering "PBB" using appropriate labels.
 - 3) Of the same manufacturer as the ground bar
 - c. A predrilled Electroplated copper busbar provided with holes for use with standard sized lugs; hole patterns shall be in TIA/BICSI style.
 - d. Have minimum dimensions of 1/4 inch thick x 4 inches wide x 20 inches long.
 - e. Provide enough length for all connections with 25% growth.
 - f. Provided with insulators to electrically isolate busbar from mounting surface.
 - g. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.

2. Manufacturer shall be
 - a. Harger TGBIP14420TMGB
 - b. Chatsworth 40153-020
 - c. Or equivalent from Component Manufacturer
- C. Secondary Bonding Busbar (SBB)
 1. Specifications
 - a. Be a predrilled Electroplated copper busbar provided with holes for use with standard sized lugs
 - b. Have minimum dimensions of 1/4 inch thick x 2 inches wide x 12 inches long
 - c. Provided with insulators to electrically isolate busbar from mounting surface
 - d. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.
 2. Manufacturer shall be
 - a. Harger TGBI14212TGB
 - b. Chatsworth # 13622-012
 - c. Or equivalent from Component Manufacturer
- D. Bonding Conductor (To main Electrical service ground) for Telecommunications (TBC): Insulated grounding wire [with a minimum copper conductor size equal to that of the TBB], with PVC insulation. Shall be UL listed.
 1. Specifications
 - a. Copper.
 - b. Insulated grounding wire with PVC insulation
 - c. A minimum copper conductor size equal to that of the largest TBB or other bonding conductor connected to the PBB, UON.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) NRTL listing information
 - e. Cable jacket shall be green with black lettering
 - f. A minimum conductor size as indicated on drawings
- E. Ground Wire (for connections within each Telecommunications Room and to Cable Tray)
 1. Specifications
 - a. Copper.
 - b. When not routed through plenum or other air-handling space: Insulated grounding wire with a minimum copper conductor size of number 6 AWG, with PVC insulation. Shall be UL listed.
 - c. When routed through plenum or other air-handling space: Non-Insulated grounding wire with a minimum copper conductor size of number 6 AWG. Shall be UL listed.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name.
 - 2) Copper Conductor Gauge.
 - 3) UL listing.
 - e. Cable jacket shall be green with black lettering.

F. Connectors / Connections

1. Specifications
 - a. All connectors and connections shall utilize products that are Listed by a NRTL such as UL.
 - b. All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc.
2. Compression Lugs
 - a. Specifications
 - 1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.
 - 2) Shall include inspection port.
 - 3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)
 - b. Manufacturer shall be:
 - 1) Harger GECLB Series
 - 2) Or Approved Equivalent
3. Conductor to conductor connection
 - a. Specifications
 - 1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.
 - b. Manufacturer – Exothermic Weld
 - 1) Erico CADWELD
 - 2) Harger Ultraweld
 - 3) Or Approved Equivalent
 - c. Manufacturer – Irreversible Compression connector
 - 1) Burndy HYGROUND
 - 2) Or Approved Equivalent
4. Connector for conduit to cable
 - a. Specifications
 - 1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the PBB/SBB.
 - b. Manufacturer shall be:
 - 1) For 1" diameter and larger conduits – Harger series CPC electro tin-plated pipe clamp
 - 2) For less than 1" diameter conduits – Harger TBGC4SCS elctro tin-plated conduit bonding clamps
 - 3) Or Approved Equivalent
5. Connector for conductor to cable tray
 - a. Specifications
 - 1) For metallic cable trays that extend to the Telecommunications Room.

- b. Manufacturer shall be:
 - 1) Harger electro tin-plated cable tray bonding clamps – TBCTC
 - 2) Or Approved Equivalent
- G. Insulated Grounding Bushings
 - 1. Specifications
 - a. All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
 - b. Shall be UL Listed for copper conductors.
 - c. Shall include lug for easy connection of conductor to PBB/SBB.
 - 2. Manufacturer shall be:
 - a. O-Z/Gedney IBC-L
 - b. Or Approved Equivalent

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.

3.02 PATHWAYS FOR COMMUNICATIONS SYSTEMS

- A. General
 - 1. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
 - 2. Permanently mark or tag each raceway at intervals of not more than 75 feet (22.86 m), and each junction box and pull box. Permanently mark or tag each raceway that is stubbed into the ceiling space from an outlet box. Identifying them as "TELECOM" or "AV" as appropriate.
 - 3. Coordinate the following with cable-installing contractor.
 - a. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
 - b. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.
 - c. Provide all communications pathways:
 - 1) So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
 - 2) So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
 - 3) So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines
 - 4) So that the maximum allowable pulling tension is not exceeded
 - 5) To meet the requirements of the structure and the requirements of all other Work on the Project.
 - 6) Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.
 - 7) Parallel or perpendicular to building lines or column lines.

- 8) When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
 - d. Follow manufacturer's recommendations for allowable fill capacity. Do not exceed load ratings specified by manufacturer.
4. Access to pathways and associated equipment
 - a. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.
 - b. Provide an access door where equipment or devices are located above inaccessible ceilings.
 - c. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
 - d. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.
- B. Conduits and Backboxes for Communications
 1. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and owner Standards (if applicable).
 2. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
 3. Conduits which enter telecommunications rooms shall extend 1 inch (25.4 mm) to 3 inches (76.2 mm) AFF.
 4. Flexible conduits may only be used where specifically allowed by these contract documents.
 - a. Flexible conduit sections shall be less than 20 feet (6.1 m) in length and shall be increased by (1) trade size
 5. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.
 6. Conduit runs shall not exceed a total of 150-feet (45.7 m).
 7. No more than (2) 90° bends, or equivalent will be allowed between pullboxes.
 - a. Each and any offset shall be considered a 90° bend.
 - b. A pullbox is required wherever a reverse bend is installed.
 8. The minimum bend radius for conduits is
 - a. (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.
 - b. (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).
 9. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
 10. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Rated partitions shall be provided with appropriately rated firestop systems. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).

11. PullBoxes

- a. Pullboxes shall be placed in Conveniently Accessible locations.
- b. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
- c. Pullboxes above an accessible ceiling shall:
 - 1) Be aligned directly over the ceiling grid to allow access
 - 2) Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles
- d. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
- e. Size pullboxes according to the following chart:

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
¾" or smaller	4"	4"	2-1/8"	Not applicable
1"	4"	16"	3"	2"
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	28"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	6"

12. Provide an empty EMT raceway from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, install raceways to the nearest accessible corridor ceiling or as indicated on the Drawings.
13. No outlet boxes shall be located back-to-back in a wall cavity.
 - a. Where possible offset to next stud cavity, but no less than a 6 inches (152.4 mm) separation.
14. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
15. Provide appropriate plaster/mud ring as indicated on the drawings.
16. Provide conduit as indicated on the Drawings or required by this Specification. Minimum communications conduit size shall be 1 inch (25.4 mm). Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as Communications, at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged.

C. Cable Tray

1. Cable trays shall be installed in accordance with manufacturer installation instructions, applicable electrical code, and standards. Comply with recommendations in NEMA VE 2.
2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.
3. Fasten cable tray supports to building structure.
 - a. Design each fastener and support to carry load indicated by seismic requirements
 - b. Place supports so that spans do not exceed maximum spans on schedules.

- c. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
 - d. Support bus assembly to prevent twisting from eccentric loading.
 - e. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
 - f. Locate and install supports according to NEMA FG 1
- 4. The inside of the cable support system shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) installed within the cable fill area shall have that portion within the tray rigidly protected with a smooth, non-scratching covering so that cable can be pulled without physical damage such as appropriately rated (plenum) plastic tubing.
- 5. A minimum of 12 inches (300 mm) access headroom shall be provided and maintained above a cable tray system or cable runway.
- 6. Test cable tray systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with maximum grounding resistance.
- D. Fire stop System Assemblies for Communications Systems
 - 1. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.
 - 2. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by approved NRTL by the AHJ and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
 - 3. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes and National Electric Code.
 - 4. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
 - a. Fire stop Manufacturer
 - b. Installer and company
 - c. Date installed
 - d. UL system number with all relevant ratings indicated

3.03 TELECOMMUNICATIONS BACKBOARD

- A. Mount Telecommunications Ground Bars (PBB and SBBs) to telecommunications backboard.

3.04 GROUNDING AND BONDING INSTALLATION

- A. General:
 - 1. Install all other ground conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. "Daisy chaining" of Telecommunications ground bus bars back to the PBB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein

2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications cable management pathways so as to achieve a "coupled bonding conductor" effect
 3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)
 4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.
 5. The Telecommunications Bonding Conductor (TBC), each Telecommunications bonding backbone (TBB) conductor, and each Backbone bonding conductor (BBC shall be green or marked with a distinctive green color.
 - a. Marking with a distinctive green color Shall be done at a minimum of every 1 foot (0.3 meter) by appropriate methods.
 - b. Indicate proposed and actual routing of these conductors on overall floor plans in both the pre-construction Shop Drawings and Record Drawings, respectively.
 6. Follow additional installation requirements from NECA/BICSI 607-2011 "Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings".
- B. Required Grounding Connections:
1. Provide and install one individual ground wire from each equipment rack/cabinet/frame (installed under this work) to the SBB in the room. Each conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
 2. Provide and install one individual ground wire from the raised floor system (if applicable) to the PBB. Conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
 3. Provide and install one individual ground wire from the overhead and vertical ladder racking (installed under this work) to the SBB in the room. All sections of ladder rack shall be securely connected together; otherwise, provide ground wire from each section of ladder rack.
 4. Where structural steel is available for connection install one individual ground wire to the nearest structural steel for connection.
 5. Provide and install all grounding connections as required by Telecommunications set of drawings.
- C. Connector Installation:
1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
 2. Follow the connector manufacturer's instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.
- D. Cable Identification:
1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following in addition to specific labeling requirements for each conductor.
- E. Quantities of Ground Wires (Conductors)
1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.

2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)

1. Subject to the applicable electrical code and the reference standards and guidelines, the TBC, TBB, BBC conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from ANSI/TIA-607):

Linear Length (ft)	AWG Size
less than 13	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 kcmil
126-150	300 kcmil
151-175	350 kcmil
176-250	500 kcmil
251-300	600 kcmil
Greater than 301	750 kcmil

G. Testing

1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.
2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.
3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):
 - a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance

1. Upon receipt of the Contractor's documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

END OF SECTION 26 0510

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Conductors, cables, and cords rated 600V and less.
- B. Connectors and terminations rated 600V and less.

1.02 DEFINITIONS

- A. The following abbreviations apply to this and other Sections of these specifications:
 - 1. MC: Metal Clad
 - 2. NBR: Acrylonitrile-butadiene rubber
 - 3. NETA ATS: Acceptance Testing Specification.
- B. The following definitions apply to this and other Sections of these Specifications:
 - 1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard.
 - a. Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and temperature deration.
 - 2. Coordinate routing of power, low-voltage, and control conduits requiring fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system for power, low-voltage, and control circuit conductors and cables shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:
 - a. Feeders for Emergency Power systems where in areas not protected by an automatic fire suppression system.
 - b. Smokeproof Enclosure Pressurization systems
 - c. Smoke Control systems
 - d. Smoke Removal systems
 - e. Fire service and Occupant Evacuation Elevator systems
 - 3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 4. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
- B. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Conductors, cables, and cords rated 600V and less.
 - b. Metal Clad (MC) cable and fittings.
 - 2. Shop drawings for:
 - a. Fire-Resistive cables, including UL 2196 certification.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.
- D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
- F. Qualification Data: For testing agency.
- G. Field quality-control test reports in accordance with NETA ATS:
 - 1. Submit all system and component test results.
- H. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.
- I. Operation and Maintenance Data: For cable and all accessories to include in operation and maintenance manuals.
- J. Follow-up service reports.

1.05 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.
- C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- D. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 70.

1.06 PROJECT CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Contract Administrator and obtain direction before proceeding with work.

- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner, or others, unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.
 - 3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
- C. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 SEISMIC REQUIREMENTS

- A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section "Seismic Controls for Electrical Systems" and Division 20 Section "Seismic Controls for MEP/F/T Systems".

PART 2 - PRODUCTS AND MATERIALS

2.01 CONDUCTORS AND CABLES - GENERAL

- A. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable.
 - 1. Solid conductors for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger
 - 2. Stranded for all flexible cords, cables, and control wiring.
 - 3. As noted otherwise below.
- B. Aluminum conductors are not allowed.
- C. Conductor Insulation: Type THHN/THWN-2 complying with ICEA S-95-658/NEMA WC70
- D. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).
- E. Conductors shall not be smaller than No. 12 AWG, with the exception of wiring for signal and pilot control circuits; and pre-manufactured whips for light fixtures which may be No. 14 AWG.
- F. Conductors installed for site electrical work shall be no smaller than No. 10 AWG CU. All site electrical branch circuit wiring shall be sized such that the maximum branch circuit voltage drop is less than 3 percent.
- G. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.
- H. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

2.02 SINGLE CONDUCTORS

- A. Manufacturers:
 - 1. Alan Wire
 - 2. Cerrowire

3. Colonial Wire & Cable Co., Inc.
 4. Encore Wire Corporation
 5. General Cable (Prysmian Group)
 6. Northern Cables Inc.
 7. Okonite Company
 8. Southwire Company
- B. 600V, insulated conductors as noted above shall be color-coded as follows, unless noted otherwise:

	<u>PHASE</u>	<u>120/240V</u>	<u>240Δ/120V</u>	<u>208Y/120V</u>	<u>480Y/277V</u>
A		Black	Black	Black	Brown
B		Red	Orange	Red	Orange
C		N/A	Red	Blue	Yellow
Neutral		White	White	White	Gray**
Equipment Ground		Green	Green	Green	Green
Isolated Ground		N/A	N/A	Green/Yellow Stripe	Green/Yellow Stripe

**Except as provided in NFPA 70.

2.03 TWO-HOUR FIRE RESISTIVE CABLES (INDIVIDUAL CONDUCTORS).

- A. Manufacturers:
 1. Radix Wire & Cable (DuraLife)
- B. Certified to UL2196 for Two-Hour Fire Resistive Cable.
- C. Cable shall be NFPA 70 compliant for use in a listed fire-resistive cable assembly and must be installed in a system meeting Electrical Circuit Integrity System (FHIT) No. 28C or 28E of the UL Fire Resistance Directory.
- D. Two-hour Certified for both vertical and horizontal installations.
- E. Conductors: Stranded soft-drawn copper, Thermal/fire barrier tape, silicone inner layer, LSZH XLPO outer layer, Rated 90 degree C.

2.04 METAL CLAD CABLE; TYPE MC

- A. General:
 1. Shall not be used for life safety or critical systems.
- B. MC Cable (with insulated green grounding conductor, no bonding conductor):
 1. Manufacturers:
 - a. Atkore/AFC Cable Systems
 - b. Cerrowire
 - c. Encore Wire Corporation (MC)
 - d. Kaf-Tech
 - e. Northern Cables, Inc.
 - f. Southwire Company (Amorlite)
 2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
 3. Armor Assembly: Aluminum interlocked armor (aluminum color).
 4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.

5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NFPA 70.
6. Marking: Cable markings shall comply with the requirements of NFPA 70.
- C. MC Cable (with 0-10V dimming control wiring):
 1. Manufacturers:
 - a. Atkore/AFC Cable Systems
 - b. Cerrowire
 - c. Encore Wire Corporation (MC- LED)
 - d. Southwire Company (MC – PCS Duo)
 2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
 3. Armor Assembly: Aluminum interlocked armor (aluminum color).
 4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
 5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NFPA 70.
 6. Control Conductors: Color-coded Class 2/Class 3 twisted jacketed pairs
 7. Marking: Cable markings shall comply with the requirements of NFPA 70.
- D. MC Cable (Two-Hour Fire Resistive Cables)
 1. Manufacturers:
 - a. Prysmian Group (Lifeline MC)
 - b. VITALink (VITALink MC)
 2. Cable shall be NFPA 70 and NFPA 101 compliant for use as a listed fire-resistive cable assembly and shall meet Electrical Circuit Integrity System (FHIT) No. 50 of the UL Fire Resistance Directory.
 3. 600V, Unjacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and the NEC, classified to UL 2196 Standard for Test for Fire Resistive Cables for two-hour installations. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
 4. Armor Assembly: Continuously welded corrugated copper armor meeting equipment grounding conductor requirements of NEC.
 5. Phase Conductors: Solid or stranded soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1, Rated 90 degree C.
 6. Marking: Cable markings shall comply with the requirements of NEC Art 310.
 7. Cable insulation and inner binder jacket: Ceramifiable Silicone Zero Halogen (LSZH).
- E. MC Cable Fittings:
 1. Manufacturers:
 - a. ABB/T&B
 - b. Arlington
 - c. Eaton/Crouse-Hinds
 - d. Emerson/O-Z Gedney

2. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.
3. Fittings shall be insulated type not requiring the use of anti-short bushings.
4. Romex style, clamp type fittings are not acceptable.

2.05 METAL CLAD CABLE – HEALTH CARE FACILITY RATED; TYPE MC- HCF

A. General:

1. Use where allowed for normal power circuits in general patient care areas.
2. Do not use for life safety or critical systems.

B. MC – HCF Cable:

1. Manufacturers:
 - a. Atkore/AFC Cable Systems
 - b. Cerrowire
 - c. Encore Wire Corporation
 - d. Southwire Company (HCF – MCAP)
2. 600V, Unjacketed and/or PVC-jacketed UL Standard 1569 for Metal-Clad cables, UL Standard 83, UL Standard 1063, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. MC cable shall be listed for use in UL 1, 2, and 3 Hour through-Penetration Firestop Systems.
3. Armor Assembly: Aluminum interlocked armor and full-sized solid bare aluminum grounding/bonding conductor in intimate and continuous contact with armor – recognized as equipment ground per NFPA 70.
4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
5. Grounding Conductor: Solid, soft-drawn copper, THHN green insulated grounding conductor sized per NFPA 70.
6. Type MC-HCF Cable shall be “Hospital Care Facility” type in accordance with NFPA 70 with raceway system listed as an equipment ground return path.
7. Marking: Cable markings shall comply with the requirements of NFPA 70. Outer armor shall have green-color for easy identification as hospital patient care rated.

C. MC – HCF Cable (with 0-10V dimming control wiring):

1. Manufacturers:
 - a. Atkore/AFC Cable Systems
 - b. Encore Wire Corporation
 - c. Southwire Company (MC-HCF-PCS Duo)
2. 600V, Unjacketed and/or PVC-jacketed UL Standard 1569 for Metal-Clad cables, UL Standard 83, UL Standard 1063, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. MC cable shall be listed for use in UL 1, 2, and 3 Hour through-Penetration Firestop Systems.
3. Armor Assembly: Aluminum interlocked armor and full-sized solid bare aluminum grounding/bonding conductor in intimate and continuous contact with armor – recognized as equipment ground per NFPA 70.
4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
5. Control Conductors: Color-coded Class 2/Class 3 twisted jacketed pairs

6. Grounding Conductor: Solid, soft-drawn copper, THHN green insulated grounding conductor sized per NFPA 70.
 7. Type MC-HCF Cable shall be "Hospital Care Facility" type in accordance with NFPA 70 with raceway system listed as an equipment ground return path.
 8. Marking: Cable markings shall comply with the requirements of NFPA 70. Outer armor shall have green-color for easy identification as hospital patient care rated.
- D. MC Cable Fittings:
1. Manufacturers:
 - a. ABB/T&B
 - b. Arlington
 - c. Eaton/Crouse-Hinds
 - d. Emerson/O-Z Gedney
 2. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.
 3. Fittings shall be insulated type not requiring the use of anti-short bushings.
 4. Romex style, clamp type fittings are not acceptable.

2.06 NONMETALLIC SHEATHED CABLE

- A. NM or NMC cable:
1. Manufacturers:
 - a. Cerrowire
 - b. Colonial Wire & Cable Co., Inc.
 - c. Encore Wire
 - d. Southwire/Romex
 2. 600V, THHN- or XHHW-insulated conductors); color code: ICEA Method 1, with green insulated or bare grounding conductor; color-coded PVC-jacket for quick identification of conductor size; UL Standards 44 or 83 (as applicable), and 719, NFPA 70.
- B. UF Cable:
1. Manufacturers:
 - a. Cerrowire
 - b. Colonial Wire & Cable Co., Inc.
 - c. Encore Wire
 - d. Southwire
 2. 600V, THHN/THWN-2 or XHHW-insulated copper conductors; color code: ICEA Method 1, with grounding conductor; Jacketed with sunlight, moisture, and fungus resistant gray PVC; UL Standards 44 or 83 (as applicable), and 493, NFPA 70.
- C. Service Entrance Cable, Style R (SER Cable):
1. Manufacturers:
 - a. Cerrowire
 - b. Encore Cable
 - c. Southwire
 2. 600V, [CU][AL] conductors; insulation as noted above; type SE multiple-cable assembly; bare ground or concentrically applied un-insulated (neutral) conductor and reinforcement tape, jacketed with sunlight resistant gray polyvinyl chloride (PVC); UL Standards 44 or 83 (as applicable), and 854, NFPA 70. Listed for above-ground use.

- D. Service Entrance Cable, Style U (USE Cable):
 - 1. Manufacturers:
 - a. Cerrowire
 - b. Encore Cable
 - c. Southwire
 - 2. 600V, [CU][AL] conductors; insulation as noted above; multiple-cable assembly; bare ground or concentrically applied un-insulated (ground/neutral) conductor and reinforcement tape, jacketed with sunlight resistant gray polyvinyl chloride (PVC); UL Standards 44 or 83 (as applicable), and 854, NFPA 70. Listed for under-ground use.

2.07 PHOTOVOLTAIC WIRE

- A. Manufacturers:
 - 1. Kris-Tech Wire
 - 2. Photovoltaiccable.com
 - 3. Service Wire Co.; ServiceSolar
- B. Sunlight-resistant, single-conductor, insulated photovoltaic wire listed and labeled as complying with UL 4703; specifically designed for interconnection wiring of photovoltaic power systems in accordance with NFPA 70. Insulation voltage rating as required for photovoltaic power system voltage.

2.08 VARIABLE-FREQUENCY DRIVE CABLE

- A. Manufacturers:
 - 1. Belden
 - 2. Service Wire Co.; ServiceDrive
- B. Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.
 - 1. Insulation shall be thermoset types. Thermoplastic insulation types are not permitted.
 - 2. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.
 - 3. Provide 100% coverage copper tape shielding.
 - 4. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.09 MANUFACTURED WIRING SYSTEMS

- A. Manufacturers:
 - 1. Acuity – ReLoc
 - 2. Cooper Industries
- B. Description: Manufactured wiring assemblies complying with NFPA 70, and listed and labeled as complying with UL 183.
- C. Provide components necessary to transition between manufactured wiring system and other wiring methods.
- D. Branch Circuit Cables:
 - 1. Conductor Stranding (Size 10 AWG and Smaller): Solid.
 - 2. Insulation Voltage Rating: 600 V.
 - 3. Insulation: Type THHN.
 - 4. Provide dedicated neutral conductor for each phase conductor.

- 5. Grounding: Full-size integral equipment grounding conductor.
 - a. Provide additional isolated/insulated grounding conductor where indicated or required.
 - b. Provide redundant grounding, suitable for general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities where indicated or required.
- 6. Armor: Steel, interlocked tape.
- E. Connectors: Keyed and color-coded to prevent interconnection of different voltages.
- F. Fixture Leads: Type TFN insulation.

2.10 CONTROL WIRING

- A. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

2.11 CONNECTORS

- A. Manufacturers:
 - 1. AMP; Tyco
 - 2. FCI-Burndy
 - 3. Gould
 - 4. Ideal Industries, Inc.
 - 5. Ilsco
 - 6. NSi Industries, Inc.
 - 7. O-Z/Gedney
 - 8. Panduit
 - 9. Thomas and Betts
 - 10. 3-M Electrical Products Division
- B. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, circumferential compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
 - 1. Termination fittings for copper conductors: Barecopper, 1-hole pad and inspection port.
- C. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
 - 1. Termination fittings: Bare copper, 1-hole pad and inspection port.
- D. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts. Color-coded for size, except use green only for grounding connections.
- E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: ring-tongue type.
- F. Connectors and terminations for aluminum conductors and cables No. 1 and larger: UL 486B listed and marked AL7CU for 75 deg C rated conductors and AL9CU for 90 deg C rated conductors.
- G. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- H. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- B. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)
- C. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.
- D. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).
- E. Where anticipated conductor installed lengths exceed the lengths indicated on the Drawings, notify Contract Administrator. Provide tabulated list of exceeded lengths for review. Increase conductor size, circuit ground size, and conduit size accordingly to meet maximum voltage drop indicated within the calculations.

3.02 INSTALLATION

- A. General
 - 1. Unless otherwise indicated on the Drawings or in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor at outlets for fixture or device connections.
 - 2. Install in accordance with manufacturer's instructions.
 - 3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 4. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
 - 5. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.
 - 6. Seal around cables penetrating fire-rated elements according to [Division 26, Common Work Results For Electrical][Division 07 Section "Penetration Firestopping"].
 - 7. Wiring at Outlets: Install conductors at each outlet with at least [12][6] inches of slack.
 - 8. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
 - 9. Multi-wire branch circuits are not allowed unless noted otherwise on the drawings.
 - 10. Where multi-wire branch circuits are utilized (i.e., shared neutral), shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two examples.
 - 11. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

12. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
13. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply, which are in addition to those in NFPA 70:
 - a. Emergency Power Circuits – includes all circuits covered under Articles 700, 701 and 702.
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: $\frac{3}{4}$ -inch. Do not install any other type of circuit in this raceway.
 - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - b. Healthcare Critical branch circuits as defined in Article 517.
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: $\frac{3}{4}$ -inch. Do not install any other type of circuit in this raceway.
 - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - c. Healthcare Life Safety branch circuits as defined in Article 517.
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: $\frac{3}{4}$ -inch. Do not install any other type of circuit in this raceway.
 - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - d. Healthcare Essential Equipment circuits as defined in Article 517.
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: $\frac{3}{4}$ -inch. Do not install any other type of circuit in this raceway.
 - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - e. Normal or Non-Essential circuits.
 - 1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: $\frac{3}{4}$ inch. For greater than eight conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.
 - 2) The minimum wire size for all conductors in this raceway: No. 10 AWG.
 - 3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - f. GFCI-protected circuits.
 - 1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.
 - g. Isolated Ground (IG) Circuits:
 - 1) Do not use multi-conductor or MC cables.
 - 2) Do not share neutrals between separate circuits.
 - 3) Do not share the isolated grounding conductor with more than one device (i.e., each device on an IG circuit shall have its own dedicated IG conductor back to the branch panelboard IG bus).
 - 4) The equipment grounding conductor may be shared between IG circuits sharing a common raceway.
14. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.
15. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.

16. Branch circuit conductors shall be copper.
17. All essential power systems circuits shall be copper.
18. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:
 - a. Wet or dry locations, in raceways:
 - 1) Service entrance: Type THWN, THHN/THWN-2, or XHHW-2.
 - 2) Feeders and branch circuits: Type THWN, THHN/THWN-2, or XHHW-2.
 - 3) Conductors No. 6 AWG and smaller: Types THWN or THHN/THWN-2.
 - 4) Conductors used between a variable frequency drive (VFD) and associated motor: Type XHHW-2.
 - b. Direct buried:
 - 1) Service entrance: USE.
 - 2) Feeders and branch circuits: UF or USE.
 - c. Fluorescent light fixtures or conductors within three feet of high temperature equipment such as heaters: Type THHN, XHHW, or higher temperature insulation as required for the use.
- B. Two-Hour Fire Resistive Cables (Individual Conductors).
 1. Cable shall be installed in a system meeting Electrical Circuit Integrity System (FHIT) No. 28C or 28E of the UL Fire Resistance Directory.
 2. Two-Hour Fire-Resistive cable may only be used:
 - a. For feeders and branch circuits where indicated on the Drawings or where a listed fire-resistive cable system is required by NFPA 70, the IBC, or other applicable codes.
 3. Two-Hour Fire-Resistive cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:
 - a. In locations not permitted by the NEC.
 - b. When specifically not allowed by the local AHJ and/or Owner.
- C. Metal Clad Type MC[and/or Metal Clad Health Care Facility type MC-HFC] Cable:
 1. Securing and Supporting:
 - a. Support per NFPA 70 for MC cable
 - b. Secure cable within 12 inches of every box or fitting.
 - c. Secure/supporting intervals shall not exceed six (6) feet for MC cable.
 - d. Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible so as to provide for cable routing in a neat and workmanship like manner.
 2. Type MC] cable may only be used:
 - a. In lieu of flexible conduit and wiring from light fixtures in accessible ceilings to junction boxes (attached to building structure) above the ceiling. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.
 - b. For vertical drops and horizontal wiring in stud walls.
 - c. In lieu of metal raceway, only for 15A and 20A branch circuits with up to four (4) conductors, not including grounding and/or bonding conductor(s), and only in dry concealed locations above grade, except where specifically not permitted by NFPA 70.
 3. MC cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:

- a. Unjacketed MC:
 - 1) In locations not permitted by NFPA 70.
 - 2) When specifically not allowed by the local AHJ and/or Owner.
 - 3) Homeruns to panelboards.
 - 4) Where exposed to view.
 - 5) Where subject to physical damage.
 - 6) Corrosive or Hazardous locations.
 - 7) Wet locations.
 - 8) Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
 - 9) Within mechanical, electrical or telecommunication equipment rooms.
 - 10) Essential systems (life safety and critical branches) of Health Care facilities except as allowed by NFPA 70.
 - 11) Emergency circuits covered by NFPA 70, unless specifically noted for use as a fire-resistive cable system.
- b. PVC Jacketed MC:
 - 1) In locations not permitted by NFPA 70.
 - 2) When specifically not allowed by the local AHJ[and/or Owner/Landlord].
 - 3) Homeruns to panelboards.
 - 4) Where exposed to view.
 - 5) Where subject to physical damage.
 - 6) Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
 - 7) Within mechanical, electrical or telecommunication equipment rooms.
 - 8) Essential systems (life safety and critical branches) of Health Care facilities except as allowed by NFPA 70.
 - 9) Emergency circuits covered by NFPA 70.
- 4. Type MC- HCF cable shall have an outer metal armor or sheath in accordance with NFPA 70. This requirement applies to MC- HCF cable installations for non-emergency (non-life safety & non-critical) circuits in General Patient Areas i.e. Patient bedrooms, examining rooms, treatment rooms, clinics, and similar areas within health care facilities including but not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers, whether permanent or movable.
 - a. This further applies to any area where it is intended that the patient will come in contact with ordinary appliances such as a nurse call system, electric instrument, cord connected equipment, electric beds, examining lamps, telephones, and entertainment devices.
 - b. Type MC- HCF Health Care Facility cable is permitted for use in general patient care areas of health care facilities. The use of standard/non-health care facility type MC or AC cable is not permitted in patient care areas.
 - c. The HCF length for power circuits shall be limited to 30 feet from the junction box to the wiring device located in the wall. If the circuit continues outside the wall, the circuit shall immediately transition to conduit.
 - d. The HCF length for lighting circuits shall be limited to 30 feet from the junction box to the first fixture and from that point only those fixtures above the enclosed space/room shall be served by this HCF circuit.

D. Metal Clad Type MC Cable (Fire-Resistive):

1. Securing and Supporting:

- a. Install, support, and terminate Fire-Resistive MC cable per manufacturer's installation instructions and per applicable codes and standards.
- b. Support MC cable per NFPA 70 and requirements of UL Electrical Circuit Integrity System FHIT 50.
- c. Secure cable within 12 inches of every box or fitting.
- d. Secure/supporting intervals shall not exceed six (6) feet for MC cable in non-fire rated installations or (4) feet in fire rated installations per UL FHIT 50.
- e. Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible in non-fire rated installations.
- f. Utilize steel slotted support systems with two-piece clamps in fire rated installations per UL FHIT 50 installations.
- g. Where multiple multi-conductor cables are installed maintain adequate spacing between cables to avoid reduction in allowable ampacities as per NFPA 70 requirements.
- h. Provide non-metallic barrier between MC cable armor and metallic supports to prevent contact between dissimilar metals.
- i. Route cabling in a neat and workmanship like manner.

2. Type MC Fire-Resistive cable may only be used:

- a. For feeders and branch circuits where indicated on the Drawings or where a listed fire-resistive cable system is required by NFPA 70, NFPA 101, the IBC, or other applicable codes.

3. Type MC Fire-Resistive cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:

- a. In locations not permitted by the NEC.
- b. When specifically not allowed by the local AHJ and/or Owner.
- c. Where subject to physical damage.
- d. Corrosive or Hazardous locations.

E. Type NM or NMC Cables:

1. When permitted for use by these documents, do not install NM or MNC cables above suspended ceilings in commercial facilities.

F. Variable-Frequency Drive Cable:

1. Use for conductors run between variable-frequency drive (VFD) and motor when distance exceeds 200 feet.
2. Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

G. Flexible Cords

1. Refer to Division 26 Section, "Equipment Wiring Systems", for electrical connections to equipment.

H. Control Wiring

1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.

2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or otherwise specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.
 - a. Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.
- I. Connections:
 1. Apply a zinc based, anti-oxidizing compound to connections.
 2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 4. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
 5. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.
 6. Use connectors as indicated in equipment schedules. Where not indicated use connections as noted below.
 - a. Compression – Conductors No. 8 AWG and larger to panelboards, switchboards and apparatus
 - b. Compression – splices, terminals
 - c. Mechanical – where temporary removal is required
 7. Do not use terminals on wiring devices to feed through to the next device.

3.03 IDENTIFICATION

- A. General: Provide all identification per Division 26 "Identification for Electrical Systems".
- B. Single Conductors: Identify and color-code conductors to indicate voltage and phase according to Part 2 of this Section. Identification method shall be either:
 1. Factory provided colored insulation
 2. Color-Coding Conductor Tape.
 3. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- C. Power-Circuit Conductor Identification: For primary and secondary conductors 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes identify voltage, source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box identify each ungrounded conductor according to voltage, source and circuit number.
- E. Conductors to Be Extended in the Future: Attach identification device to conductors and list source and circuit number.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- G. Conductors for controls (lighting, controls): Label each conductor with Markers for Conductor and Control Cables. – identify conductors using method as noted in Division 26 Section "Identification for Electrical Systems". Note conductor identification on record Drawings.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- I. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- J. Low voltage cable sheath labels and related manufacturer information shall remain apparent in all exposed applications.
 1. Protect exposed cabling labels from painting and overspray (this includes protection of cables in cable tray)

3.04 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
- C. Testing: Perform the following field quality-control testing:
 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.
 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.
- D. Test Reports: Prepare a written report to record the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 0519

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. This Section includes:
 - 1. Grounding Electrodes
 - 2. Ground Bars
 - 3. Grounding Conductors
 - 4. Connector Products
 - 5. Equipotential Grounding System
 - 6. Miscellaneous Grounding Materials and Products

1.02 DEFINITIONS

- A. The following apply to this and other Sections of these Specifications:
 - 1. Ground ring: Bare underground grounding conductor encircling the building or structure.
 - 2. NETA ATS: Acceptance Testing Specification.
 - 3. PSF: Pounds per Square Foot
 - 4. EMT: Electrical metallic tubing.
 - 5. ENT: Electrical nonmetallic tubing.
 - 6. FMC: Flexible metal conduit.
 - 7. GRS: Galvanized Rigid Steel Conduit
 - 8. IMC: Intermediate metal conduit.
 - 9. LFMC: Liquidtight flexible metal conduit.
 - 10. LFNC: Liquidtight flexible nonmetallic conduit.
 - 11. RAC: Rigid Aluminum Conduit
 - 12. RMC: Rigid Metal Conduit
 - 13. RNC: Rigid nonmetallic conduit.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Electrodes, mechanical and compression connectors, and exothermic connectors .
 - 2. Shop drawings for:
- B. Qualification Data: For [a qualified testing and inspecting agency engaged by] Contractor.
- C. Quality-Control Test Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 1. Accurately record actual locations of all buried electrodes, bonding conductors and ground rings. Indicate dimensions from fixed structural elements.

1.04 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 2. Marked for intended use.
 3. Comply with UL 467.
- E. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.01 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

- A. Manufacturers:
 1. ABB, Inc.
 2. Advanced Lightning Technology (ALT)
 3. AFL Global
 4. Boggs, Inc.
 5. Burndy; Hubbell.
 6. Cooper Power; Eaton.
 7. Copperweld Corp.
 8. ECN/Korns; Division of Robroy Industries.
 9. Erico; nVent.
 10. Galvan Industries, Inc.
 11. Greaves Corp.
 12. Harger.
 13. Hastings Fiber Glass Products, Inc.
 14. Heary Brothers Lightning Protection Co.
 15. Ideal Industries, Inc.

16. ILSCO.
17. Lightning Master Corp.
18. Lyncole XIT Grounding; Division of VFC.
19. O-Z/Gedney Co.; Emerson.
20. Panduit, Inc
21. RACO; Hubbell, Inc.
22. Robbins Lightning, Inc.
23. Superior Grounding Systems, Inc.

2.02 GROUNDING ELECTRODES

- A. Ground Rods: UL-listed:
 1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
 2. Hot-dip galvanized steel; minimum zinc thickness specified per ASTM A-123.
 3. Stainless steel; Type 304.
 4. Size: 5/8 inch by 8 feet. Provide sectional types when longer rods are indicated.
- B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a bare conductor sized, at a minimum, for the size of the connecting grounding electrode conductor.
- C. Ground Plates: UL-listed, rectangular, bare solid copper plate; minimum 0.032-inch thick.
- D. Ground Ring:
 1. Bare copper grounding conductor, size as noted on Drawings but not less than #2/0 AWG.

2.03 GROUND BARS

- A. General
 1. Ground bars described in this section are intended to be wall mounted bars used for grounding and bonding. Equipment ground buses for switchboards, panelboards and miscellaneous equipment are described in the individual equipment sections.
 2. Supports: Minimum of two each 1-1/2-inch insulators and 1-inch stainless steel offset mounting brackets.

2.04 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
- B. Material:
 1. Aluminum.
 2. Copper-clad aluminum.
 3. Copper.
- C. Equipment Grounding Conductors: Insulated and identified as indicated in Part 3 of this section.
- D. Isolated Ground Conductors: Insulated and identified as indicated in Part 3 of this section.
- E. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
- F. Bare Copper Conductors:
 1. Solid Conductors: Comply with Conductors: ASTM B 8.
 2. Tinned Conductors: Comply with ASTM B 33.

- G. Copper Bonding Conductors:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.
- H. Aluminum Bonding Conductors:
 - 1. Bonding Cable: 10 strands of No. 14 AWG aluminum conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded aluminum conductor.
 - 3. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; 1-5/8 inches wide and 1/16 inch thick.
- I. Ground Ring:
 - 1. Bare copper grounding conductor, size as noted on Drawings but not less than #2/0 AWG.
- J. Ground Conductor and Conductor Protector for Wood Poles: As follows:
 - 1. No. 4 AWG minimum, soft-drawn copper conductor.
 - 2. Conductor Protector: Half-round PVC or wood molding. If wood molding is utilized, use pressure-treated fir, or cypress or cedar.

2.05 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors.
- C. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
 - 1. Company symbol and/or logo.
 - 2. Catalog number.
 - 3. Conductors accommodated.
 - 4. Installation die index number or die catalog number is required.
 - 5. Underwriters Laboratories "Listing Mark:".
 - 6. The words "Suitable for Direct Burial" or, where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467.
- D. Cast connectors: copper base alloy according to ASTM B 30.
- E. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.06 EQUIPOTENTIAL GROUNDING SYSTEM

- A. Operating and Delivery room ground modules: Post-Glover #RRP4-26 with 6 ground jacks, 2 twist locks receptacles and ground bus in a single housing with stainless steel trim.
- B. Ground modules in locations, other than Operating and Delivery rooms: Post-Glover #GJP-3-06 with 6 ground jacks and a ground bus in a single housing with stainless steel trim.

2.07 MISCELLANEOUS

- A. Test Wells:
 - 1. Traffic Areas: Polymer concrete reinforced with heavy weave fiberglass; H-20 load rating; minimum 24 inches deep.

2. Non-traffic Areas: High density polyethylene; 350 PSF minimum load rating; minimum 10.25 inches deep.
 3. Cover: Factory-identified by permanent means with word "GROUND".
- B. Ground Enhancing Backfill: Provide low-resistivity, ground-enhancing backfill material recommended by the electrode manufacturer.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Contract Administrator and the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General:
1. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of NFPA 70 and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.
 2. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.
 3. Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Application:
1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- C. Grounding Electrode System: Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
1. Provide continuous grounding electrode conductors without splice or joint.
 2. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 3. Ground Rod Electrodes:
 - a. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
 - b. Unless otherwise indicated, install ground rod electrodes vertically.
 - 1) Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
 - 2) Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
 - c. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70. If depth is unachievable, notify Contract Administrator and Engineer.
 - d. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

- e. Verify that final backfill and compaction has been completed before driving rod electrodes.
 - f. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade, pavement, or floor.
 - 4. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches. Use exothermic weld to secure grounding electrode conductor.
 - 5. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 6. Ground Ring Electrode (Counterpoise):
 - a. Provide a ground ring encircling the building or structure, in direct contact with earth., installed at a depth of not less than 18 inches or 6 inches below the official frost line, whichever is greater.
 - b. Locate ground ring conductor at least 24 inches outside building perimeter foundation, unless noted otherwise on the Drawings.
 - c. Provide ground enhancement material around conductor where indicated.
 - 7. Metal In-Ground Support Structures: Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
- D. Equipment Grounding Conductors:
- 1. Comply with NFPA 70, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
 - 2. Install equipment grounding conductors in all feeders and branch circuits.
 - 3. Install equipment grounding conductor with circuit conductors for the following items, in addition to those required by NFPA 70:
 - a. Feeders and branch circuits.
 - b. Lighting circuits.
 - c. Receptacle circuits.
 - d. Single-phase motor and appliance branch circuits.
 - e. Three-phase motor and appliance branch circuits.
 - f. Flexible raceway runs.
 - g. Armored and metal-clad cable runs.
 - h. Feeders and branch circuits installed in non-metallic raceways.
 - 4. In branch circuit and feeder raceways, use insulated equipment grounding conductors.
 - 5. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
 - 6. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components. On water heaters, bond metal hot and cold water pipes together, across the heater tank.
 - 7. Busway Supply Circuits: Install an insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panelboard to the equipment

- grounding bar terminal on the busway, if a direct bus-to-bus connection is not factory provided.
8. **Metallic Cable Tray Systems:** Install equipment grounding conductor in each cable tray. Do not use metal cable tray system as sole equipment grounding conductor.
 - a. **Equipment Grounding Conductor for Steel Cable Tray:** Use bare or insulated copper conductor.
 - b. **Equipment Grounding Conductor for Aluminum Cable Tray:** Use insulated copper conductor only; do not use bare copper conductor.
 - c. **Minimum Equipment Grounding Conductor Size:** 6 AWG copper.
 9. **Nonmetallic Raceways:** Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- E. **Ground Bars:**
1. Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.
 - a. Use insulated spacers and mounting brackets, and support from wall 2 feet above finished floor, unless otherwise indicated.
- F. **Signal and Communication Systems:** For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. **Service and Central Equipment Locations and Wiring Closets:** Terminate grounding conductor on a ground bar.
 2. **Terminal Cabinets:** Terminate grounding conductor on cabinet grounding terminal.
- G. **Separately Derived Systems:** Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the Drawings or as required by NFPA 70, whichever is larger.
- H. **Bonding:** Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70:
1. **Bonding Straps and Jumpers:** Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
 2. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
 3. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
 4. Bond metallic elements likely to become energized or where indicated on the Drawings, including but not limited to fences around electrical equipment and metal drain bodies near pools or electrical equipment.
 5. Bond raised flooring systems and static control flooring.

6. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
7. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in PVC conduit.
8. Pole Mounted Luminaires: Bond metal enclosures and components of pole mounted luminaires to the grounding system per the Manufacturer's requirements.
9. Bond the components within the following systems to the building grounding system:
 - a. Metallic Cable Tray Systems.
 - b. Photovoltaic Systems.
- I. Isolated Ground (IG) Receptacle Circuits:
 1. Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
 2. Do not use multi-conductor or MC cables.
 3. Do not share neutrals between separate circuits.
 4. Do not share the isolated grounding conductor with more than one device (i.e., each device on an IG circuit shall have its own dedicated IG conductor back to the branch panelboard IG bus).
 5. The equipment grounding conductor may be shared between IG circuits sharing a common raceway
- J. Isolated Equipment Enclosure Circuits:
 1. For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

3.03 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:
 - 1. Connecting conductors together.
 - 2. Connecting conductors to ground rods, except at test wells.
 - 3. Connecting conductors to building steel.
 - 4. Connecting conductors to plates.
- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
 - 1. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:
 - a. Connecting conductors together.
 - b. Connecting conductors to building steel.
 - c. Connecting conductors to ground rods, except at test wells.
- D. Mechanical Pressure-Type Connections: Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A[and UL 486B].
 - 1. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:
 - a. Connecting conductors to ground rods at test wells.
 - b. Connecting conductors to pipes.
- E. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted-and clamped-type connections between conductors and ground rods.
- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.04 GROUND RING

- A. Ground the steel framework of the building with a buried electrode at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Protect taps for steel framing connections from physical damage at foundations and transitions to steel columns.

3.05 EQUIPOTENTIAL GROUNDING SYSTEM

- A. Equipotential grounding system shall consist of No. 10 AWG stranded copper conductors connecting all exposed metal objects and metal building surfaces (within 6'-0" beyond the reach of the patient) to the patient grounding point or room bonding point and ultimately to the reference grounding point.

- B. The grounding connection between patient grounding points, room bonding points, reference grounding point, isolation power centers, panelboards, etc. shall be a stranded copper conductor sized as indicated on the Drawings. The system shall conform to NFPA 70.
- C. Provide an equipotential grounding system in the following areas:
 - 1. Operating Rooms
 - 2. Delivery Rooms
 - 3. Emergency Treatment Rooms
 - 4. Intensive Care Areas
 - 5. Cardiac Care Areas Recovery Rooms
 - 6. Dialysis Units
- D. Connect conductive flooring to the room bonding point by means of a No. 10 AWG bare copper conductor extending a minimum of 3'-0" into the room under the flooring.

3.06 RADIOLOGY GROUNDING

- A. All Radiology grounding systems shall be provided as directed by the equipment manufacturers. No variation shall be made from the manufacturer's requirements. Consult the manufacturer's power and grounding requirements for the imaging modality being served.

3.07 POOL GROUNDING AND BONDING

- A. Grounding: Provide copper equipment grounding conductors for all pool equipment and electrical equipment within corrosive environments as defined by and in accordance with NFPA 70, including but not limited to the following:
 - 1. Pool pumps.
 - 2. Motors.
 - 3. Flexible cord connections.
 - 4. Through-wall assemblies, unless noted otherwise.
 - 5. Luminaire circuits.
 - 6. Panelboard Feeders.
 - 7. Audio equipment exceeding the low voltage contact limits as defined in NFPA 70.
- B. Bonding: Bond all metal parts, fittings, piping, and raceway associated with pool construction per NFPA 70.
 - 1. Equipotential Bonding: Where practicable, bond conductive pool shell utilizing the structural steel reinforcing per NFPA 70. Otherwise, provide a copper grid for equipotential bonding consisting of No. 8 AWG solid copper and arranged in accordance with NFPA 70. Bond all metallic components, underwater lighting, metallic raceways and piping, through-wall assemblies, metal fittings, metallic anchors, electrical equipment, all fixed metal parts, and controls within 5'-0" (1.5m) of the pool, pool lifts and all specialized pool equipment.
 - 2. Provide an equipotential bonding ring within pool equipment space with solid bare copper conductor. Bonding ring shall be sized equivalent to the largest phase conductor serving the pool equipment but shall not be less than 8 AWG.
- C. Grounding terminals for pool equipment or electrical equipment located within the pool area and pool corrosive environments, as defined in NFPA 70, shall be copper, copper or stainless steel and listed for wet location and direct burial. The equipment grounding conductor shall be connected to the fixed portion of an assembly. Ensure removable parts of an assembly are bonded appropriately in accordance with the Manufacturer's written instructions.

3.08 FOUNTAIN GROUNDING AND BONDING

- A. Grounding: Provide copper equipment grounding conductors for all fountain circulation equipment, and luminaires and electrical equipment within the fountain or within 5'-0" (1.5 m) of the fountain edge, in accordance with NFPA 70.

- B. Bonding: Bond for all metal parts, fittings, piping, and raceway associated with the fountain per NFPA 70.
- C. Grounding terminals for fountain equipment or electrical equipment located within the pool area and pool corrosive environments, as defined in NFPA 70, shall be copper, copper or stainless steel and listed for wet location and direct burial. The equipment grounding conductor shall be connected to the fixed portion of an assembly. Ensure removable parts of an assembly are bonded appropriately in accordance with the Manufacturer's written instructions.

3.09 GROUNDING AND BONDING FOR BODIES OF WATER

- A. Grounding: Provide insulated copper equipment grounding conductor for feeders and branch circuits serving equipment and devices within or adjacent to natural and artificially made bodies of water in accordance with NFPA 70.
- B. Bonding: Bond all non-current carrying metal enclosures, parts, fittings, tanks and piping in contact with the water. Bond associated structures or equipment located within or adjacent to natural and artificially made bodies of water in accordance with NFPA 70. Use solid copper conductor not less than No. 10 AWG for bonding conductors.
- C. Equipotential Plane: Install equipotential planes as indicated on the plans. Bond outdoor service equipment to equipotential plane per NFPA 70.

3.10 OVERHEAD-LINE GROUNDING

- A. Comply with IEEE C2 requirements. Use two or more parallel ground rods if a single ground rod electrode resistance to ground exceeds 25 ohms.
- B. Drive ground rods to a depth of 12 inches below finished grade in undisturbed earth.
- C. Ground Rod Connections: Use clamp-type connectors listed for the purpose for underground connections and connections to rods.
- D. Lightning Arresters: Separate arrester grounds from other grounding conductors.
- E. Secondary Neutral and Tank of Transformer: Interconnect and connect to grounding conductor.
- F. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

3.11 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Run conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise encircling the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade, or 6 inches below the official frost line, whichever is greater, and 6 inches from the foundation.

3.12 IDENTIFICATION

- A. Provide identification as specified in Division 26 "Low-Voltage Electrical Power Conductors and Cables" and "Identification for Electrical Systems".

3.13 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
- C. Testing: Perform the following field quality-control testing:
 - 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests by the fall-of-potential method according to IEEE 81.
 - 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - 4. Inspect and test in accordance with NETA ATS, except Section 4.
 - 5. Perform inspections and tests listed in NETA ATS, Section 7.13.
 - 6. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 7. Perform point-to-point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
 - 8. Test Values:
 - a. The resistance between the main grounding electrode and earth ground shall be no greater than 5 ohms.
 - b. Equipment Rated 500 kVA and Less: 10 ohms.
 - c. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - d. Equipment Rated More Than 1000 kVA: 3 ohms.
 - e. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - f. Manhole Grounds: 10 ohms.
 - 9. Minimum system neutral-to-ground insulation resistance: one megohm.
 - 10. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - a. Check for loose connections.
 - b. Check for absent or broken connections.
 - c. Check for poor quality welds.
 - d. Consider other reasons.
 - 11. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements
 - 12. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.
 - 13. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.14 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

3.15 EXISTING INSTALLATIONS

- A. Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Where applicable, verify the neutral and ground are properly bonded at the point of service entrance. Notify the Landlord, Owner and the Engineer of any existing deficiencies.

END OF SECTION 26 0526

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SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.02 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
 - 6. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
 - 7. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members in path of conduit groups with supports.
 - 2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.
- C. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Submit fabrication drawings and product literature.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
 - 3. Rooftop support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - a. Include strength derating requirements related to ambient temperature.
 - 4. Equipment supports.
- C. Welding certificates.

1.06 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70 and applicable building code.
- C. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. General:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
- B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly. Use corrosion resistant materials suitable for the environment where installed.
 - 1. [Available]Manufacturers:
 - a. Allied Tube & Conduit; Atkore International.
 - b. Eaton
 - c. Erico; nVent.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings:
 - a. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
 - b. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 1. [Available]Manufacturers:
 - a. Allied Tube & Conduit.
 - b. Eaton.
 - c. Enduro Composites.
 - d. Fabco Plastics Wholesale Limited.
 - e. Seasafe, Inc.
 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 4. Rated Strength: Selected to suit applicable load criteria.
 5. Flammability: Fire retardant with NFPA 101, Class A flame spread index (maximum of 25) when tested in accordance with ASTM E84; self-extinguishing in accordance with ASTM D635.
- D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- E. Conduit and Cable Support Devices: [Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
 1. Conduit Straps: One-hole or two-hole type.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
- F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Powder or Battery-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Powers Fasteners, Inc;
 - 5) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- I. Wire Rope Hanging Systems:
 1. Manufacturers:
 - a. Gripple.
 2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
 3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
 4. Wire Rope: Zinc coated, stainless steel or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.
 5. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

2.02 FABRICATED METAL CONDUIT OR EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.
- C. Rooftop support assemblies: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane.
 1. Conduit supports: Unless noted otherwise, surface mounted fittings not requiring any attachment to the roof structure and not penetrating the roofing assembly with support fixtures.
 2. Equipment supports: Attachment fittings for connection to roof structure.
- D. Base Sizes: As required to prevent overturning and to distribute load sufficiently to prevent indentation of roofing assembly.
- E. Mounting Height: Provide minimum clearance of 6 inches under supported components to top of roofing.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Unless specifically indicated or approved by the Contract Administrator and Structural Engineer, do not support from roof deck.
- C. Where support wires are permitted, identify independent electrical component support wires above accessible ceilings with color distinguishable from ceiling support wires in accordance with NFPA 70.
- D. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - 1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - 2. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
- E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:
 - 1. Minimum rod size shall be 1/4 inch (6 mm) in diameter, unless otherwise indicated.
 - a. Equipment Supports: 1/2 inch diameter minimum.
 - b. Busway Supports: 1/2 inch diameter minimum.
 - c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter minimum.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter minimum.
 - 2. Space supports for EMT, IMC, and RMC as required by NFPA 70.
- F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with:
 - a. two-bolt conduit clamps
- G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- H. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Supported load shall not exceed manufacturer's recommended load rating.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Install in accordance with manufacturer's instructions.
- E. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- F. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum

static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

1. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
- G. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
- H. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- I. Remove temporary supports when no longer required.
- J. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- K. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 - a. Instead of expansion anchors, powder or battery-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 5. To Steel:
 - a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts
 - b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
 - c. Spring-tension clamps.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate
- L. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.
- D. Minimize overhanging materials and protrusions, and provide protective caps and fittings on exposed material ends where:
 1. Accessible to untrained personnel.
 2. Located within confined spaces.

- E. Rooftop support assemblies:
 - 1. Conduit supports: Unless noted otherwise, coordinate installation of support system after roofing materials are complete. Provide adhesive materials to secure conduit supports where required. Where attachment to roof structure is required or otherwise specified, coordinate installation of supports with roofing material installation.
 - 2. Equipment supports: Coordinate installation of supports with roofing material installation.

3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 "Concrete".
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Comply with requirements in Division 09 "Finishes" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- D. Inspect support and attachment components for damage and defects. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 26 0529

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SECTION 26 0533
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.01 SECTION INCLUDES

A. This Section includes:

1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.02 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. EMT: Electrical Metallic Tubing
2. FMC: Flexible Metal Conduit
3. GRS: Galvanized Rigid Steel Conduit
4. IMC: Intermediate Metal Conduit
5. LFMC: Liquidtight Flexible Metal Conduit
6. LFNC: Liquidtight Flexible Nonmetallic Conduit
7. RAC: Rigid Aluminum Conduit
8. RMC: Rigid Metal Conduit
9. RNC: Rigid Nonmetallic Conduit
10. RTRC: Reinforced Thermosetting Resin Conduit

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of raceway, boxes, or other potential obstructions within the dedicated equipment spaces and working clearances for equipment installed by other trades in accordance with the codes and manufacturer requirements.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate routing of power, low-voltage, and control conduits requiring fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system for power, low-voltage, and control circuit conductors and cables shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:
 - a. Feeders for Emergency Power systems where in areas not protected by an automatic fire suppression system.

- b. Smokeproof Enclosure Pressurization systems
- c. Smoke Control systems
- d. Smoke Removal systems
- e. Fire service and Occupant Evacuation Elevator systems

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Shop drawings for:
 - 1. Detailing fabrication and installation for custom enclosures.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members in path of conduit groups with supports.
 - 2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.
- D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record actual routing of all exterior buried raceway and all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.

1.05 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 - 2. Marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.01 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

- A. Metal Conduit and Tubing
 - 1. Available Manufacturers:
 - a. ABB, Inc.
 - b. Atkore
 - c. American Conduit
 - d. Anamet Electrical, Inc.
 - e. Electri-Flex Co.
 - f. Hubbell (Fittings).
 - g. Nucor Tubular Products.
 - h. O-Z/Gedney Co.; Emerson.
 - i. Southwire Company, LLC
 - j. Western Tube and Conduit Corporation.
 - k. Wheatland Tube Co.

2. RMC:
 - a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.
 - 1) Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.04 inches (1mm), minimum.
 - b. RAC: ANSI C80.5, UL6A.
 3. IMC: ANSI C80.6, UL 1242.
 - a. Plastic-Coated IMC and Fittings: NEMA RN 1, UL-listed.
 4. EMT and Fittings: ANSI C80.3, UL 797. Only steel products allowed. Reduced wall EMT is not allowed.
 - a. Fittings: Set-scre[or Compressio] type.
 5. FMC: Aluminum or Zinc-coated steel: UL 1. Reduced wall FMC is not allowed.
 6. LFMC: Flexible steel raceway with PVC jacket: UL 360.
 - a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Nonmetallic Raceway
1. Available Manufacturers:
 - a. ABB, Inc.
 - b. American Pipe and Plastics, Inc.
 - c. Anamet Electrical, Inc.
 - d. Atkore
 - e. Cantex Inc.
 - f. Carlon
 - g. Champion Fiberglass, Inc.
 - h. Electri-Flex Co.
 - i. Hubbell Inc. (Fittings)
 - j. IPEX USA, LLC.
 - k. Prime Conduit.
 - l. Southwire Corporation.
 - m. Superflex Ltd.
 - n. United Fiberglass of America, Inc.
 2. RNC: Schedule 40 and 80 PVC: NEMA TC 2, UL 651.
 - a. Fittings: match to raceway and tubing type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
 3. ENT: NEMA TC 13, UL-listed.
 - a. Fittings: match to tubing type and material: NEMA TC 13, NEMA TC 6, UL 651, as applicable.
 4. LFNC: UL 1660.
 - a. Fittings: match to tubing type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
- C. Metal Wireways
1. Available Manufacturers:
 - a. BEL Products, Inc.
 - b. Cooper B-Line; Eaton.

- c. EPI-Electrical Enclosures
 - d. Hoffman.
 - e. Square D.
 - 2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA 1, 3R, 12, or 4X.
 - 3. Fittings and Accessories: Include couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.
 - 4. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.
- D. Nonmetallic Wireways
- 1. Available Manufacturers:
 - a. ABB, Inc.
 - b. Enduro Composite Systems
 - c. Hoffman.
 - 2. Description: Fiberglass reinforced polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Gasketed cover with oil-resistant gasket material.
 - a. Corrosion resistant captive screws
 - 3. Description: PVC, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
 - 4. Fittings and Accessories: Include couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - 5. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Surface Metal Raceways
- 1. Available Manufacturers:
 - a. ABB, Inc.
 - b. Hubbell, Inc.
 - c. Legrand.
 - d. Mono-Systems; Niedax Group
 - e. Panduit Inc.
 - 2. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
 - 3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
- F. Surface Nonmetallic Raceways
- 1. Available Manufacturers:
 - a. ABB, Inc.
 - b. Enduro Composite Systems.
 - c. Hubbell, Inc.
 - d. Legrand.

- e. Mono-Systems, Inc.
- f. Panduit Inc.
- 2. Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
- 3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.02 BOXES, ENCLOSURES AND CABINETS

A. General

- 1. Available Manufacturers:
 - a. ABB, Inc.
 - b. American Midwest Power
 - c. Appleton/O-Z Gedney Co.; Emerson.
 - d. BEL Products, Inc.
 - e. Cooper Crouse-Hinds; Eaton.
 - f. Erickson Electrical Equipment Co.
 - g. FSR, Inc.
 - h. Hoffman.
 - i. Hubbell, Inc.
 - j. Legrand.
 - k. Molex; Koch Industries.
 - l. Robroy Industries, Inc.; Enclosure Division.
 - m. Spring City Electrical Manufacturing Co.
- 2. Provide products listed, classified, and labeled as suitable for the purpose intended. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
- 3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
- 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

- 1. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
- 2. Cast Metal Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover. Furnish with threaded hubs.
 - a. List and label as complying with UL 514A for non-hazardous locations;.
 - b. List and label as complying with UL 886 for hazardous locations, where required.
- 3. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
- 4. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
- 5. Boxes for Ganged Devices: Use multi-gang boxes of single-piece construction. Do not use field-connected gangable boxes.

6. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Wall Plates: Comply with Division 26 Section "Wiring Devices".
- C. Boxes for telephone, data, telecommunications and audio-video outlets, refer to:
 1. Division 26 Section "Common Work Results for Communications"
- D. Junction and Pull Boxes Larger Than 100 cubic inches:
 1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, and list and label as complying with UL 514A.
 2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron or aluminum with gasketed cover.
 3. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 4. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
- E. Cabinets and Enclosures:
 1. General:
 - a. Compliance: NEMA 250, and list and label as complying with UL 50 and UL50E or 508A, as applicable.
 - b. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes: Shall be keyed. Provide 2 keys for each enclosure.
 - 1) All locks shall be keyed alike.
 - c. NEMA 250 Environment ratings:
 - 1) NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.
 - 2) NEMA Type 3R: Code-gauge galvanized steel with drip shield top, seam-free front, side, and back; non-gasketed continuous-hinged door, with stainless steel pin; captive, plated steel cover screws; hasp and staple for padlocking; collar studs.
 - d. Removable painted steel interior panel mounted on standoffs; metal barriers to separate wiring of different systems and voltages.
 - e. Removable painted plywood interior panel mounted on standoffs; metal barriers to separate wiring of different systems and voltages.
 - f. Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.
 - g. Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring. Provide wire management troughs where practicable.
 - h. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

2.03 FACTORY FINISHES

- A. Interior Finish: All interior components shall be factory finished; manufacturer's standard grey unless otherwise noted.
- B. Exterior Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- C. Exterior Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide ANSI 61 grey applied to factory-assembled metal wireway and surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General
 - 1. Install in accordance with manufacturer's instructions.

3.02 RACEWAYS

- A. General
 - 1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.
 - 2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 1/2 inch (concealed and exposed); 1 inch (underground and under slab).
 - a. 1/2-inch conduit shall contain maximum (5) #12AWG conductors or (3) #10AWG conductors.
 - b. 3/8-inch flexible conduit may be used for light fixture whips.
 - 3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.
 - 4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.
 - 5. Install grounding bushings or other code compliant connections on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.
 - 6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Contract Administrator, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.
 - 7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
 - 8. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
 - 9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
 - 10. Install raceways:
 - a. To meet the requirements of the structure and the requirements of all other Work on the Project.
 - b. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.

- c. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.
 - d. Parallel or perpendicular to building lines or column lines.
 - e. Tight to structure.
 - f. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- 11. Raceways Embedded in Slabs:
 - a. Raceways may only be embedded in concrete slabs with written permission from, and only where directed, by the Structural Engineer.
 - b. Install in middle 1/3 of slab thickness, where practical. At a minimum, concrete shall provide at least 2 inches of concrete cover for raceways.
 - c. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - d. Space raceways laterally to prevent voids in concrete.
 - e. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - f. Change from RNC to coated GRS or IMC before rising above the floor.
- 12. Where masonry, brick, CMU or concrete walls are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.
- 13. Where masonry, brick, CMU or concrete walls in public spaces are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.
- 14. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section "Hangers and Supports for Electrical Systems". Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.
 - a. Raceways on roof shall be supported from structure not from the roof deck.
- 15. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:
 - a. Attach single raceway directly to structural steel with beam clamps.
 - b. Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.
 - c. Attach groups of raceways to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.
 - d. Attach groups of raceways to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.
 - e. Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.

- f. Hang horizontally suspended groups of raceways using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.
 - g. Support conductors in vertical raceway in accordance with NFPA 70 requirements.
 - h. Cross-brace suspended raceway to prevent lateral movement during seismic activity.
 - i. Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.
- 16. Install electrically and physically continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flaking the finish.
- 17. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Contract Administrator's approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.
- 18. Align and install raceway terminations true and plumb.
- 19. Complete raceway installation before starting conductor installation.
- 20. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.
- 21. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints; or where structures providing a means of support are subject to relative movement greater than acceptable by the raceway manufacturer.
- 22. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Contract Administrator, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Contract Administrator, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.
- 23. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.
 - b. Where otherwise required by NFPA 70.
- 24. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment as required by other requirements of the construction documents.; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- 25. Maintain 2" minimum spacing from bottom of roof deck to prevent raceway penetrations from above.
- 26. Do not route conduits across skylights, access panels, hatched tiles, HVAC diffusers, or equipment working space.
- 27. Route conduits serving rooftop equipment concealed inside the equipment curb and minimize roof penetrations and exterior conduit runs where practicable.

28. Install all underground conduits/raceways, outside the building footprint, a minimum of 24" below the bottom of paving/grade, unless noted otherwise, where practicable.
29. Install all underground conduits/raceways underneath building footprint slab-on-grade a minimum of 12" below bottom of slab, unless noted otherwise, where practicable.
30. Where conduits are subject to earth movement by settlement or frost, provide expansion fittings to prevent damage to enclosed conductors or connected equipment.
31. Provide boxes and raceways for the fire protection system low voltage wiring as required. This includes low voltage wiring exposed less than 96" AFF.
 - a. At a minimum, provide 3/4" conduit.
 - b. Coordinate requirements and locations with system installer and fire alarm specifications.

B. RMC

1. Use GRS or IMC in the following areas:
 - a. Where indicated.
 - b. For Emergency Feeders.
 - c. Exterior applications where above grade and exposed.
 - d. Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.
 - e. All raceways penetrating slabs on grade (use plastic-coated raceway or provide with a corrosion resistant approved mastic coating). This shall include the 90-degree elbow below grade and the entire vertical transition to above grade.
 - f. Exposed, in parking garages:
 - 1) GRS: vertical risers below 7 feet AFF, when exposed to vehicular traffic.
 - g. Conductors over 600 volts.
 - h. Concealed within masonry walls.
 - i. Damp or wet locations.
 - j. Elevator pits.
 - k. Crawl spaces
 - l. Interior spaces where exposed to damage. Includes but is not limited to the following areas.
 - 1) Loading dock
 - 2) Corridors used for traffic of mechanized carts, forklifts and pallet handling units.
 - m. <Insert additional locations>
2. Use RAC in the following areas:
 - a. Only where specifically indicated on the Drawings.
 - b. Indoors above grade.
 - c. Interior wet or damp locations.
 - d. For circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
3. Do not use RAC:
 - a. Below grade.
 - b. Imbedded in concrete or other areas corrosive to RAC.

C. EMT

1. Use EMT in the following areas:
 - a. Where indicated.
 - b. Interior concealed locations for:
 - 1) Branch circuits.
 - 2) Feeders.
 - 3) Emergency branch circuits.
 - 4) Low-voltage control, security, and fire alarm circuits
 - c. Exposed where not subject to physical damage
 - 1) Mechanical rooms
 2. Do not use EMT:
 - a. Below grade.
 - b. In exterior applications when exposed.
- D. RNC
1. Solvent-weld RNC fittings and raceway couplings per the manufacturer's instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.
 2. Where installed exposed outdoors or other areas subject to temperature variations, install expansion fittings per NFPA 70, to accommodate thermal expansion in straight runs.
 3. RNC is only allowed to be used in the following locations:
 - a. Where specifically indicated.
 - 1) If an adopted code prevents use of RNC in a location where the contract documents specifically allow its use, contractor shall utilize other types of conduit allowed by the specification.
 - 2) Allowed does not mean required.
 - b. Underground, single and grouped, in lieu of GRS or IMC, when indicated.
 - 1) Direct buried
 - 2) Concrete-encased (use approved rigid PVC interlocking spacers, selected to provide minimum duct spacing and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts).
 4. Phenolic Conduit (RTRC) listed for use in UL 2196 2-Hour Fire Resistive systems may be used as part of a FHIT 2-hour listed fire resistive system where a 2-hour listing is required.
- E. Telephone and Signal/Data System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

3.03 RACEWAY FITTINGS:

- A. Compatible with raceways and suitable for use and location.
- B. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.
- C. PVC Externally Coated, Rigid Steel Conduits: Use only fittings and installation tools approved by the manufacturer for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits. Replace all fittings and conduits that have any portion of the coating scraped off to bare metal, at no additional cost to the Owner.
- D. Join raceways with fittings designed and approved for that purpose and make joints tight.
- E. Use insulating bushings to protect conductors at raceway terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

3.04 WIREWAYS:

- A. Use flat head screws, clips and straps to fasten wireways to surfaces. Mount plumb and level.
- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Close ends of wireway and unused raceway openings.

3.05 BOXES:

- A. General
 1. Verify locations of device boxes prior to rough in.
 2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.
 3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.
 4. Install boxes to preserve fire ratings of walls, floors, and ceilings.
 5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.
 6. Support boxes independently of raceway.
 7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.
 8. Adjust flush-mounted boxes to make front edges flush with finished wall material.
 9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.
 10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.
- B. NEMA Enclosure ratings, Suitable for the environment in which it is installed. At a minimum, provide the following ratings:
 1. NEMA 250, type 3R
 - a. Provide at exterior locations
 2. NEMA 250, type 1
 - a. Provide at interior and dry locations
 3. NEMA 250 type 4 stainless steel
 - a. Provide at interior damp or wet locations
 - b. Provide at interior locations where associated device is labeled as Weather Proof and/or Weather Resistant, unless requirement below already requires box to be rated otherwise.
 4. NEMA 250 type 4X
 - a. Provide at interior locations subject to corrosion
- C. Outlet Boxes

1. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Contract Administrator. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.
 2. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.
 3. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 4. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 5. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 6. Use cast aluminum boxes where aluminum rigid metal conduit is used.
 7. Use nonmetallic boxes where exposed rigid PVC conduit is used.
 8. Use suitable concrete type boxes where flush-mounted in concrete.
 9. Use suitable masonry type boxes where flush-mounted in masonry walls.
 10. Use raised covers suitable for the type of wall construction and device configuration where required.
 11. Use shallow boxes where required by the type of wall construction.
 12. Install extension and plaster rings as required by NFPA 70.
 13. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.
 14. Do not exceed allowable fill per NFPA 70.
 15. Where multiple devices are shown grouped together, gang mount with a common cover plate.
- D. Junction and Pull Boxes
1. Install junction and pull boxes above accessible ceilings and in unfinished areas.
 2. Provide boxes set flush in painted walls or ceilings with primer coated cover.
 3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.
 4. Boxes for exterior use shall be:
 - a. PVC with a UV-stabilized PVC cover sealed and gasketed watertight.
 - b. Cast aluminum with a cast aluminum cover sealed and gasketed watertight.
 - c. Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.
 - d. Install buried boxes so that box covers are flush with grade, unless indicated otherwise.
- E. Floor Boxes
1. Use cast or non-metallic floor boxes for installations in slab on grade. Unless otherwise indicated, formed steel boxes are acceptable for slabs above grade.
 2. Set metal floor boxes level and flush with finished floor surface.

3. Set non-metallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.06 CABINETS AND ENCLOSURES:

- A. Unless otherwise indicated on the Drawings, provide
 1. NEMA 1 construction for indoor, dry locations
 2. NEMA 12 for indoor, damp and dusty locations
 3. NEMA 4X for outdoor locations
 4. NEMA 4X for indoor wet and corrosive locations
- B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.
- C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.
- D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.
- E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.
- F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

3.07 IDENTIFICATION

- A. Refer to Division 26 Section "Identification for Electrical Systems" for identification materials.
 1. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size. Use the following means of identification:
 - a. Spray paint at boxes.
 - b. Self-Adhesive Vinyl Labels
 - c. Snap-Around Labels
 - d. Snap-Around, Color-Coding Bands
 - e. Self-Adhesive Vinyl Tape
 2. Color for Printed Legend:
 - a. Power Circuits: Black letters on an orange field.
 - b. Legend: Indicate system or service and voltage, if applicable
- B. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

- C. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches (50 mm) high. Repeat legend at 10-foot (3-m) maximum intervals.
- D. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identification device shall be:
 - 1. Self-adhesive vinyl label
 - 2. Snap around label
 - 3. Self-adhesive vinyl tape applied in bands.
- E. Accessible Raceways of Auxiliary Systems: Identify the following systems using the same identification device as other accessible raceways 600V or less, and with the indicated color scheme for each system:
 - 1. Fire Alarm System: Red.
 - 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 - 3. Combined Fire Alarm and Security System: Red and blue.
 - 4. Security System: Blue and yellow.
 - 5. Mechanical and Electrical Supervisory System: Green and blue.
 - 6. Telecommunication System: Green and yellow.
 - 7. Control Wiring: Green and red.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- G. Junction Boxes and Pull Boxes:
 - 1. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.
 - 2. The junction box where a homerun ends and the circuit is distributed shall be marked. Junction boxes shall be marked approximately every 100 feet along homerun path to panel.

END OF SECTION

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following:
 - 1. Nameplates.
 - 2. Labels for raceways and metal-clad cable.
 - 3. Labels for junction boxes and pull boxes.
 - 4. Labels for wiring devices and lighting control devices.
 - 5. Markers for conductors, and control cables.
 - 6. Tags.
 - 7. Warning labels and signs.
 - 8. Instruction signs.
 - 9. Miscellaneous identification products.
 - 10. Painted Identification.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.
- B. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- C. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- D. Coordinate installation of identifying devices with location of access panels and doors.
- E. Install identifying devices before installing acoustical ceilings and similar concealment.

1.03 SUBMITTALS

- A. Product Data: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements" for each electrical identification product indicated:
 - 1. Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
 - 2. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.04 QUALITY ASSURANCE

- A. Electrical Equipment, Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with ANSI A13.1 and ANSI C2.
- C. Comply with requirements of NFPA 70.
- D. Comply with 29 CFR 1910.145.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. Location, text, and method of identification to be used is noted in individual sections. Refer to other sections for additional identification requirements.

2.02 NAMEPLATES

- A. Comply with UL RP 9691, Recommended Practice for Nameplates for Use in Electrical Installations.
- B. Engraved, Laminated Acrylic or Melamine Label: Non-conductive phenolic with beveled edges.
1. [Adhesive backed.][Punched or drilled for screw mounting.]
 2. Minimum 1/16 inch (1.6 mm) thick for nameplates with both dimension 4 inches (102 mm) or less and 1/8 inch (3.2 mm) thick for larger sizes.
- C. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
- D. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
- E. Text: Minimum text height shall be 1/8 inch (3.2 mm) unless otherwise required by local jurisdiction or owner standards. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.
- F. Colors:
1. Normal systems - white letters on a black background.
 2. Emergency systems - white letters on a red background.
- G. Label Requirements:
1. Service Equipment Label
LINE 1: NOMINAL VOLTAGE AND FREQUENCY IN HERTZ
LINE 2: SERVICE EQUIPMENT BUS RATING IN AMPS
LINE 3: SCCR OF SERVICE EQUIPMENT IN AMPS
LINE 4: MAXIMUM AVAILABLE FAULT CURRENT IN AMPS
LINE 5: DATE CALCULATED

EXAMPLE:

208Y/120V, 60HZ 800A SCCR = 65,000A MAX AVAILABLE FAULT CURRENT = 58,815A CALCULATED: 01/01/2018

2. Panelboard/Switchboard Label:
LINE 1: PANELBOARD/SWITCHBOARD DESIGNATION
LINE 2: VOLTAGE, PHASE, WIRES, AMPS
LINE 3: FED FROM " "

EXAMPLES:

H1A 480Y/277V, 3PH, 4W, 200A FED FROM MDB

L1A 208Y/120V, 3PH, 4W, 225A FED FROM H1A VIA XFMR T1

3. Transformer Label:
LINE 1: TRANSFORMER DESIGNATION
LINE 2: FED FROM " "
LINE 3: SUPPLIES " "

EXAMPLE:

T1 FED FROM H1A SUPPLIES L1A

4. Disconnect Switch Label:
LINE 1: DESIGNATION OF EQUIPMENT SERVED BY DISCONNECT
LINE 2: VOLTAGE, PHASE, WIRES, AMPS
LINE 3: FED FROM " "

EXAMPLES:

WATER HEATER WH1 480V, 3PH, 3W, 100A FED FROM MDB

2.03 LABELS FOR RACEWAYS AND METAL-CLAD CABLE

- A. Factory Painted Raceways:
1. Metal Raceways: Continuous, rust-inhibiting paint factory applied.
 2. Non-Metallic Raceways: Factory dyed or colored PVC sleeve.
- B. Factory Painted Metal-Clad Cable: 2-inch wide, factory painted bands at a maximum of 6-foot on center spacing.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.04 LABELS FOR JUNCTION BOXES AND PULL BOXES

- A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.05 LABELS FOR WIRING DEVICES AND LIGHTING CONTROL DEVICES

- A. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.
- B. Engraved, Laminated Acrylic or Melamine Label: adhesive backed. Minimum letter height shall be 3/16 inch (4.76 mm).
1. Normal systems - white letters on a black background.
 2. Emergency systems - white letters on a red background

- C. Engraved cover plates: Provide with white letters. White or ivory cover plates shall have black letters.
- D. Permanent Ink: Permanent, waterproof, black ink marker, hand printed legibly.

2.06 MARKERS FOR CONDUCTOR AND CONTROL CABLES

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.
- D. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

2.07 TAGS

- A. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.08 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.
- B. Self-Adhesive Warning Labels: Factory pre-printed or machine-printed multicolor self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
 - 1. Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 2. Do not use labels designed to be completed using handwritten text.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 1. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 - 1. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning (208 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

3. Workspace Clearance Warning (480 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (915 MM)."

2.09 ARC FLASH WARNING LABELS

- A. General: All labels will be based on recommended overcurrent device settings and will be printed after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system. Refer to Division 26 section "Power System Studies" for additional requirements.
- B. Materials: Use machine-printed, high adhesion, polyester label; UV, chemical, water, heat, and abrasion resistant, for each work location analyzed.
- C. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer. Labels shall be machine printed, with no field markings. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
- D. Minimum Size: 3.5 inch by 5 inch (89 mm by 127 mm), unless otherwise noted by Owner.
- E. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment. The label shall include the following information, at a minimum:
 1. Location designation
 2. Nominal voltage
 3. Available fault current
 4. Limited approach boundary
 5. Arc flash boundary
 6. Restricted approach boundary
 7. Hazard risk category
 8. Incident energy
 9. Working distance
 10. Site-specific PPE (personnel protective equipment) requirements.
 11. Date calculations were performed.
 12. Engineering report number, revision number and issue date.

2.10 INSTRUCTION SIGNS

- A. Engraved, Laminated Acrylic or Melamine plastic: Non-conductive phenolic. Unless indicated otherwise, provide with minimum 3/8-inch- (10-mm-) high letters. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.
 1. Minimum 1/16 inch (1.6 mm) thick for nameplates with either dimension greater than 4 inches (102 mm) and 1/8 inch (3.2 mm) thick for larger sizes.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
 4. Normal systems: Engraved legend with white letters on black face.
 5. Essential Systems: Engraved legend with white letters on red face.
- B. Stainless Steel Nameplates: Minimum thickness of 1/32 inch ; engraved or laser-etched text.
- C. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text

D. Colors:

1. General Information and Operating Instructions – Black letters on white background.
2. Normal systems - white letters on a black background.
3. Emergency systems - white letters on a red background.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Fasteners for Nameplates, Labels and Signs

1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

2.12 PAINTED IDENTIFICATION

A. Paint materials and application requirements are specified in Division 09 painting Sections.

1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior concrete and masonry primer.
 - 2) Finish Coats: Exterior semi-gloss acrylic enamel.
2. Exterior Concrete Unit Masonry:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Exterior semi-gloss acrylic enamel.
3. Exterior Ferrous Metal:
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior ferrous-metal primer.
 - 2) Finish Coats: Exterior semi-gloss alkyd enamel.
4. Exterior Zinc-Coated Metal (Except Raceways):
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior zinc-coated metal primer.
 - 2) Finish Coats: Exterior semi-gloss alkyd enamel.
5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior concrete and masonry primer.
 - 2) Finish Coats: Interior semi-gloss alkyd enamel.
6. Interior Concrete Unit Masonry:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.

7. Interior Gypsum Board:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior gypsum board primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
8. Interior Ferrous Metal:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior ferrous-metal primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
9. Interior Zinc-Coated Metal (Except Raceways):
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify identity of each item before installing identification products.
- B. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.
- C. Provide identification product listed for the location in which it is to be installed.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Painted Identification: Prepare surface and apply paint according to Division 09 painting sections.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. For surfaces that require finish work, apply identification devices after completing finish work. Do not install identification products until final surface finishes and painting are complete.
- C. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed. Replace labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.
- D. Location: Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance without interference with operation and maintenance of equipment. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Conduits: Legible from the floor.
 8. Boxes: Outside face of cover.
 9. Conductors and Cables: Legible from the point of access.
 10. Devices: Outside face of cover.

- E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
 - 1. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- G. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.
 - 1. Indoor Clean, Dry Locations: Use plastic nameplates, unless noted otherwise.
 - 2. Outdoor Locations: Use [plastic][, stainless steel][, or][aluminum] nameplates suitable for exterior use.
- H. Install identification products centered, level, and parallel with lines of item being identified.
- I. Mark all handwritten text, where permitted, to be neat and legible.
- J. For refrigeration systems: Neatly bundle circuits and clearly tag and label each circuit with panelboard, branch circuit designation and refrigeration system number at each termination.

END OF SECTION 26 0553

SECTION 26 0923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following lighting control devices:
 - 1. Line-voltage dimming wall switches.
 - 2. Line-voltage wall switch occupancy sensors.
 - 3. Line-voltage dimming wall switch occupancy sensors.
 - 4. Line-voltage occupancy sensors.
 - 5. Line-voltage photoelectric switches.
 - 6. Stand-Alone Low-voltage occupancy sensors.
 - 7. Stand-Alone Low-voltage photoelectric switches.
 - 8. Stand-Alone Low-voltage power packs.
 - 9. Stand-Alone Low-voltage switches.
 - 10. Outdoor motion sensors.
 - 11. Time switches.
 - 12. Lighting contactors.
 - 13. Automatic load control relays.
 - 14. Branch circuit transfer switches.
 - 15. Conductors and Cables for Lighting Control Devices.

1.02 DEFINITIONS

- A. Acoustic Type: Occupancy sensor detection type that detects occupancy by listening for acoustic noises.
- B. Closed loop: Photosensor control algorithm designed for influence by both daylight and electric light in a space or area.
- C. DPDT: Double pole, double throw.
- D. DPST: Double pole, single throw.
- E. Dual-Technology Type: Occupancy sensor detection type that detects occupancy by using a combination of PIR and ultrasonic or acoustic detection technologies.
- F. LED: Light-emitting diode.
- G. Open loop: Photosensor control algorithm designed for influence by daylight entering in a space or area.
- H. PIR Type: Passive infrared. Occupancy sensor detection type that detects occupancy by sensing a combination of infrared heat and movement.
- I. SPST: Single pole, single throw.
- J. Ultrasonic Type: Occupancy sensor detection type that detects occupancy by sensing a change in pattern of reflected ultrasonic energy.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.04 SUBMITTALS

- A. Product data for the following products:
 - 1. Catalog cut sheets, including major and minor motion coverage patterns sensors, time delay and sensitivity adjustability settings, load restrictions, and performance specification items indicating compliance with this specification for all lighting control devices.
- B. Shop Drawings:
 - 1. Occupancy sensors and photoelectric switches
 - a. Show installation details.
 - b. Lighting plan showing location, mounting height, orientation and coverage area of each sensor and coordination with other trades.
 - c. Interconnection diagrams showing field-installed wiring.
 - d. Include diagrams for power, signal, and control wiring.
 - e. For any manufacturer submitted other than that listed as the Basis of Design, provide the following information for Engineer review:
 - 1) Factory-generated occupancy sensor and photoelectric switch layouts on project lighting plans with sensor location, orientation and product type clearly marked on plans. Sensor placement shall be coordinated with project reflected ceiling plan layout, ceiling heights, lights, diffusers, and any other ceiling devices and equipment.
 - 2) List of any deviations to this specification or Basis of Design products.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
 - 1. Occupancy sensors and photoelectric switches:
 - a. Manufacturer's installation instructions, including instructions for storage, handling, protection, examination, preparation, start-up calibration and installation.
 - b. Product data clearly showing sensor field adjustments, including dip switch setting definitions and location of settings within sensors.
 - c. Manufacturer's maintenance, including operating and adjustment instructions.
 - 2. Timeclocks
 - a. Description of programmed timeclock settings at time of substantial completion.
 - 3. Line-voltage wall box dimming switches
 - a. Provide operating instructions for each type of dimmer.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Occupancy sensors and photoelectric switches
 - 1. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of 5 years.
 - 2. Products shall be manufactured by an ISO 9001 certified manufacturing facility.
 - 3. Manufacturer shall test all equipment prior to shipment.

1.06 WARRANTY

- A. Manufacturers shall provide a five (5) year warranty for sensors and accessories from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL INFORMATION

A. PIR type requirements:

1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
2. Sensor shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
3. Sensor shall provide high immunity to false triggering from RFI and EMI.
4. Sensor shall have a multiple-segmented fresnel lens in a multiple-tier configuration, with grooves to eliminate dust and residue buildup. Sensor shall be capable of accepting mask inserts to mask specific portions of the lens to prevent false triggering.

B. Ultrasonic type requirements:

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Frequency (Small Area – 500 sq ft and less): Ultrasonic operating frequency shall be crystal controlled at 40 kHz within +/- 0.005% tolerance to assure reliable performance and eliminate sensor cross-talk.
3. Detection Frequency (Medium and Large Areas – greater than 500 sq ft): Ultrasonic operating frequency shall be crystal controlled at 32 kHz within +/- 0.005% tolerance, to assure reliable performance and eliminate sensor cross-talk.
4. Sensors shall be capable of automatically adapting to airflow conditions or filtering frequency spectrum related to air movement.

C. Acoustic type requirements:

1. Detector Sensitivity: Acoustic type technology shall only be used as secondary to PIR in a Dual-Technology Type sensor. Specific sensitivity is based on PIR technology.
2. Sensors shall distinguish noises made by human activity (typing, talking, eating, etc.) and filter out noises made by the environment or building (HVAC, equipment, cars, etc.).
3. Acoustic technology shall enhance reliability and accuracy of PIR sensor.

D. Dual-Technology type requirements:

1. Dual-Technology sensors using ultrasonic technology shall have field-selectable controls on unit to determine if a particular technology or combination of technologies controls the on-off function.
2. Dual-Technology sensors using acoustic technology shall have the PIR technology initially detect motion and a combination of PIR and acoustic technologies shall keep the load on.
3. Sensitivity Adjustment: Separate for each sensing technology.
4. Different LED indicator colors for each sensing technology
5. PIR sensor component shall comply with all requirements listed under PIR type requirements.
6. Ultrasonic sensor component shall comply with all requirements listed under Ultrasonic Type requirements.
7. Acoustic sensor component shall comply with all requirements listed under Acoustic Type requirements.

2.02 LINE-VOLTAGE DIMMING WALL SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

- B. Dimmer shall be suitable for dimmed load type of connected light fixture. Load types shall be as indicated on Drawings and confirmed per load type for connected luminaire as indicated in Light Fixture Schedule and approved light fixture and dimmer shop drawings.

2.03 LINE VOLTAGE WALL SWITCH OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C), unless indicated elsewhere for specific model and application.
 - 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
 - 4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.
 - a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
 - b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of the switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.
 - 5. Operation adjustment: Concealed, field-adjustable for auto-on or manual-on operation.
 - 6. Time Delay adjustment:
 - a. Concealed, field-adjustable.
 - b. Time delay for de-energizing loads shall be adjustable with multiple increments from 30 seconds up to 30 minutes.
 - 7. Adaptive technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
 - 8. Mounting: Single-gang wall box switch
 - 9. Finish: Sensor finish shall be [white][off-white][black][as directed by the Architect][as indicated on the Drawings].
 - 10. Sensor:
 - a. Vandal-resistant lens
 - b. Integral sliding blinders or pre-cut tape strips to block sensor views
 - c. Protrudes no greater than 0.50 inches from wall.
 - d. 180-degree field of view
 - e. Major and minor motion coverage patterns confirmed per Nema WD7 guidelines.
 - f. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.
 - 11. Indicators:
 - a. LED indicator for visual detection of motion
 - b. audible and/or visual alerts for pending shut-off
 - 12. Suitable for switching load types used, including LED, fluorescent, incandescent, magnetic and electronic low voltage and motor load types. UL listed and labeled, zero-cross relay, no minimum load requirement, ground wire.

13. Wall switch shall have no leakage of current to load and integral service switch to permit a maintained off for servicing of lamps for safety purposes
14. Buttons/Relays: Provide control relay and push button quantities as indicated by model listed in Lighting Control Device Schedule.
15. Restriction on leakage to grounding conductor.
 - a. For remodel projects and where indicated specifically on plans, dual-technology wall switch sensors, where the manufacturer does not require a neutral conductor to device and does not have more than 0.5ma leakage of current to ground per UL requirements, are not required to have a neutral conductor connected to them. Manufacturers that do not comply with the abovementioned UL requirements are not acceptable.

2.04 LINE-VOLTAGE DIMMING WALL SWITCH OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors:
 1. Comply with all requirements listed under Line-Voltage Dimming Wall Switches in this specification and,
 2. Comply with all requirements listed under Line-Voltage Wall Switch Occupancy Sensors in this specification.

2.05 LINE-VOLTAGE OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors. Integral relay unit for line voltage sensors.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. UL Listed for dry locations and complies with local codes.
 3. Operation: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Upon occupancy of space, loads shall turn on. If occupancy is not detected within the time delay period, loads shall de-energize. Time delay for de-energizing loads shall be adjustable over a minimum range of 1 to 15 minutes with a maximum of 30 minutes.
 4. Switch Rating: As indicated in Lighting Control Device Schedule.
 5. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.
 6. Mounting: Suitable for mounting in any position on a standard outlet box.
 7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 8. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.
 9. Bypass Switch: Override the "on" function in case of sensor failure, concealed on unit to prevent tampering.
 10. Finish: Sensor finish shall be [white][off-white][black][as directed by the Architect][as indicated on the Drawings].
 11. Operating temperatures: Unless indicated otherwise for specific models, 32 degree F through 104 degree F, and relative humidity of 0%-95%.
 12. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage

patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.

13. Device shall include isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems as indicated on the Drawings
14. Device and related relays shall be compatible with the specific load types controlled.
15. Sensor:
 - a. Coverage pattern: As indicated in Lighting Control Device Schedule, and shall have been confirmed with NEMA WD7 Guide and Robotic test method.
 - b. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.

C. High-Bay Model:

1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
2. Detection Coverage: Selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

D. Extreme Temperature Model:

1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
2. Operating Ambient Conditions: Temperatures from minus 40 to plus 125 degree F.

2.06 LINE-VOLTAGE PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. Outdoor:
 1. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photoelectric switch to prevent fixed light sources from causing turn-off.
 - b. Time Delay: 15-second minimum, to prevent false operation.
 - c. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 - d. Mounting: Base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.07 STAND-ALONE LOW-VOLTAGE OCCUPANCY/VACANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensor unit, for use with a separate stand-alone low-voltage power pack containing a line-voltage relay.
 1. Occupancy sensors and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. UL Listed for dry locations and complies with local codes.
4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.
 - a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
 - b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of a separate, associated switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.
5. Switch Rating: As indicated in Lighting Control Device Schedule.
6. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.
7. Mounting: Suitable for mounting in any position on a standard outlet box.
8. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
9. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.
10. Bypass Switch: Override the "on" function in case of sensor failure, concealed on unit to prevent tampering.
11. Finish: Sensor finish shall be [white][off-white][black][as directed by the Architect][as indicated on the Drawings].
12. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.
13. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.
14. Sensors:
 - a. Sensor shall be compatible with lighting control system.
 - b. Sensors shall be capable of being combined with additional sensors to achieve adequate coverage.
 - c. Sensor coverage pattern: AS indicated on Lighting Control Device Schedule, and shall have been confirmed with Nema WD7 Guide and Robotic test method.
 - d. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.
- C. High-Bay Model:
 1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
- D. Extreme Temperature Model:
 1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
 2. Operating Ambient Conditions: Temperatures from minus 40 to plus 125 degree F.

2.08 STAND-ALONE LOW-VOLTAGE PHOTOELECTRIC SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for switches: Ceiling-mounted, solid-state indoor photoelectric switch, for use with a separate stand-alone low-voltage power pack, containing a line-voltage relay.

1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. UL Listed for dry locations and complies with local codes.
 4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Upon ambient light level measurement reading below setpoint, loads shall be de-energized. Upon ambient light level measurement reading above setpoint, loads shall be energized.
 5. Finish: Sensor finish shall be [white][off-white][black][as directed by the Architect][as indicated on the Drawings].
- C. Indoor:
1. [Photoelectric switches shall be [Open Loop] [or] [Closed Loop] as indicated on the Lighting Control Device Schedule on the Drawings.]
 2. Description: Solid state, low voltage with contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the lighting control system or as indicated on the Drawings.
 - a. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
 - b. Time Delay: 30-second minimum, to prevent false operation.
 - c. Mounting: Twist lock complying with IEEE C136.10, with base.
- D. Outdoor:
1. Description: Solid state, low voltage with contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered as indicated on the Drawings.
 - a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
 - b. Time Delay: 30-second minimum, to prevent false operation.
 - c. Lightning Arrester: Air-gap type.
 - d. Mounting: Twist lock complying with IEEE C136.10, with base.

2.09 STAND-ALONE LOW-VOLTAGE POWER PACKS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for power packs: Box mounted, solid-state indoor power pack/relay unit, for use with a separate stand-alone low-voltage sensor and switches.
1. Power packs and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. UL Listed for dry locations and complies with local codes.
 4. Unit shall include isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems as indicated on the Drawings
 5. Relay shall be compatible with the specific lighting types controlled.

6. Operations: Refer to drawings for Sequence of Operations or other operational instructions. Unit operates in conjunction with other system components. Refer to operations requirements of associated devices.
7. Switch Rating: As indicated in Lighting Control Device Schedule.
Mounting: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

2.10 STAND-ALONE LOW-VOLTAGE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for switches: Wall-mounted, solid-state indoor manual switch, for use with a separate stand-alone low-voltage power pack, containing a line-voltage relay.
 1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. UL Listed for dry locations and complies with local codes.
 4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Manual push of any button shall energize or de-energize loads.
 5. Mounting: Suitable for mounting in any position on a standard outlet box.
 6. Indicator: LED, for each button to indicate when loads are energized and de-energized.
 7. Finish: Sensor finish shall be [white][off-white][black][as directed by the Architect][as indicated on the Drawings].
 8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

2.11 OUTDOOR MOTION SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors: Solid-state outdoor motion sensors.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Weatherproof, detection technology as indicated in the Lighting Control Device Schedule on the Drawings.
 3. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
 4. Detection Coverage: As indicated in Lighting Control Device Schedule on the Drawings.
 5. Switch Rating: Line Voltage: Minimum 1000-W incandescent and 500-VA ballast load at 120-V ac; 1000W ballast load at 277-V ac. Voltage as indicated on Drawings and Lighting Control Device Schedule.
 6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 1 to 20 FC. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

7. Concealed, field-adjustable, "off" time-delay selector with multiple increments from 30 seconds up to 15 minutes.
8. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 14 to plus 130 deg F, rated as "rain tight" according to UL 773A.
9. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box and ½" threaded nipple for use with standard NEMA weatherproof fixture fitting.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
10. Bypass Switch: Override the on function in case of sensor failure.

2.12 TIME SWITCHES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. Area Lighting Research, Inc.; Tyco Electronics.
 2. Intermatic, Inc.
 3. Leviton Mfg. Company Inc.
 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 5. Paragon Electric Co.; Invensys Climate Controls.
 6. Square D; Schneider Electric.
 7. TORK; NSI Industries.
 8. Wattstopper; a Legrand Company.
- D. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
 1. Contact Configuration: SPST.
 2. Contact Rating: 30-A inductive or resistive, 240-V ac, 20-A ballast load, 120/240-V ac.
 3. Program: 2 channels; each channel shall be individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
 4. Circuitry: Allow connection of a photoelectric switch relay as substitute for on-off function of a program.
 5. Astronomic Time: All channels.
 6. Battery Backup: For schedules and time clock.

2.13 LIGHTING CONTACTORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 2. Eaton Electrical Inc.; Cutler-Hammer Products.

3. GE Industrial Systems; Total Lighting Control.
 4. Hubbell Lighting.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. Square D; Schneider Electric.
 7. TORK; NSI Industries.
- D. Description: Electrically operated and mechanically held, combination type with non-fused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including LED tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation. Refer to FCA value on drawings, at nearest upstream device.
 3. Enclosure: Provide with enclosure complying with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- E. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
1. Monitoring: On-off status.
 2. Control: On-off operation.

2.14 AUTOMATIC LOAD CONTROL RELAYS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
1. For control of emergency lighting circuits: Loss of normal power shall cause relay to automatically shunt emergency power to lighting circuit regardless of manual or automatic switch position. Emergency lighting circuit shall continue to operate at full power until normal power has been restored.
 2. Coil Rating: 120 or 277 V, as indicated on Drawings.
 3. Mounting: as indicated on the Drawings. Mount per manufacturer's instructions.

2.15 BRANCH CIRCUIT TRANSFER SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 1008.
1. For control of emergency lighting circuits: Loss of normal power shall cause relay to automatically shunt emergency power to lighting circuit regardless of manual or automatic switch position. Emergency lighting circuit shall continue to operate at full power until normal power has been restored.
 2. Coil Rating: 120 or 277 V as indicated on Drawings.

2.16 CONDUCTORS AND CABLES FOR LIGHTING CONTROL DEVICES

- A. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.
- B. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG.

- C. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG.
- D. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG.
- E. Provide all necessary conductor and cabling required for operation of the controls and control systems specified. This includes power and control wiring required for the controls to operate as described.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL

- 1. Install devices and associated power packs and wiring in accordance with manufacturer's instructions and applicable codes.

B. LINE VOLTAGE WALL SWITCHES

- 1. Install dimming wall switches to achieve full rating specified on Lighting Control Device Schedule taking into account de-rating for ganging as instructed by the manufacturer.
- 2. Provide a separate grounded (neutral) conductor for each circuit controlled by a line voltage switch.
 - a. Do not share neutral conductor on load side of dimmers.
 - b. If neutral termination is not required for the device, cap conductor and tag as "Neutral for future use".

C. OCCUPANCY/VACANCY SENSORS AND PHOTOELECTRIC SWITCHES

- 1. Arrange a pre-installation meeting with manufacturer's factory authorized field representative, at Owner's facility, to verify placement of sensors and installation criteria.
- 2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage areas specified in manufacturer's literature. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas that are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective areas.
- 3. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems and partition assemblies.
- 4. Occupancy sensors with ultrasonic or dual-technology sensing technologies shall be located not closer than 4 feet from the nearest edge of air supply devices or similar obstructions that would adversely affect the sensor performance.
- 5. Adjust time delay setting of occupancy sensors to de-energize loads after space has been unoccupied for period of time indicated on the Drawings.
- 6. Install outdoor photoelectric switches with clear view of the northern sky unless noted otherwise on the Drawings.
- 7. Adjust settings of photoelectric switches to turn on lighting at illumination level indicated on the Drawings.
- 8. Install devices and auxiliary equipment in compliance with manufacturer's instructions and recommendations.
- 9. Install relay units where concealed from view and where accessible.
- 10. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

11. Install switchbox mounted occupancy sensors at same elevation as other lighting control switches.

D. TIME SWITCHES

1. Install time switches in locations as indicated on the Drawings.
2. Program time switches with current time and date information in accordance with manufacturer's instructions.
3. Program timeclock settings as per Sequence of Operations on the Drawings. Confirm final timeclock settings with Owner prior to programming.

E. LIGHTING CONTACTORS

1. Install lighting contactors in locations as indicated on the Drawings.
2. Provide NEMA 1 enclosures for lighting contactors in interior dry locations, NEMA 3R enclosures for lighting contactors in exterior or wet locations[, and NEMA 4X enclosures for lighting contactors in corrosive environments].
3. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

F. AUTOMATIC LOAD CONTROL RELAYS

1. When used with manual controls, install emergency shunt relay in separate enclosure adjacent to associated light switch. Label within enclosure the connected normal and emergency circuits.
2. When used with automatic controls, install where concealed from view in accessible ceiling near the automatic control device or wall mounted within electrical room. Label outlet box cover with connected normal and emergency circuits.

G. BRANCH CIRCUIT TRANSFER SWITCHES

1. Install branch circuit transfer switches where concealed from view in accessible ceiling near the automatic control device or wall mounted within electrical room. Label outlet box cover with connected normal and emergency circuits.

H. WIRING

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be [1/2 inch (13 mm)][<insert size>].
2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.02 IDENTIFICATION

- A. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."
- B. Power and control wiring: Identify using marker tapes.
 1. Identify controlled circuits in lighting contactors.
 2. Identify circuits or luminaries controlled by photoelectric switches and occupancy sensors at each sensor.
- C. Components: Label each component with self-laminating computer printed labels, using a unique designation matching control drawing.
- D. Cover plates: Refer to drawings for labeling requirements of certain cover plates for manual switches, or similar devices, requiring labeling for user information.

- E. Buttons/switches:
 - 1. Engraved from manufacturer. Refer to drawings for detailed requirements and text for labeling.

3.03 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Test all occupancy sensors in test mode to confirm sensor coverage and sensitivity of sensor per manufacturer's instructions. Upon completion of tests, set sensor time delay as indicated on Lighting Control Device Schedule. Follow testing and adjustment procedures as written in the manufacturer's installation instructions for each sensor model.
- B. Lighting control devices that fail tests and inspections are defective work. Remove, replace, and retest devices that fail tests.

3.04 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- B. Photoelectric switch Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project for this purpose.

3.05 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Lighting Control Systems."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training" for additional information

END OF SECTION 26 0923

SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles: Single, duplex, USB/duplex, USB-only, twist-lock, ground-fault circuit interrupters (GFCI), surge protective device (SPD), isolated ground (IG) and tamper resistant (TR).
 - 2. AC Wall Switches: Single- and double-pole, three- and four-way, maintained and momentary, pilot light and lighted toggle.
 - 3. Device Wall Plates.
 - 4. Service/Power Poles and Multi-Outlet Assemblies.
 - 5. Emergency Power Off Buttons

1.02 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. IG: Isolated Ground
- C. PIR: Passive Infrared.
- D. RFI: Radio Frequency Interference
- E. SPD: Surge Protective Device
- F. USB: Universal Serial Bus
- G. TR: Tamper Resistant

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products:
 - 1. Provide manufacturer's catalog information specifically marked to indicate which devices are being furnished, and showing dimensions, colors, and configurations for all devices, including, but not limited to: Receptacles, AC wall switches, cover plates, power poles, and multi-outlet assemblies.
- C. Shop drawings for:
 - 1. List of legends and description of materials and process used for pre-marking wall plates.
- D. Samples:
 - 1. One for each type of device and wall plate specified, in each color specified.
 - 2. Samples will be returned after review, and, if accepted by the Architect and Engineer, may be installed on the Project.
- E. Field quality-control test reports.
- F. Operations and Maintenance Data:
 - 1. Provide re-ordering instructions and directions for replacement surge modules for SPD receptacles.
 - 2. Warranty: Special warranties specified in this Section.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.
- B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.
- C. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- D. Comply with NFPA 70.

1.05 COORDINATION

- A. Receptacles for Equipment Furnished by Owner or Under Other Divisions or Contracts: Match plug configurations.

1.06 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Wall Plates: One for every 10 of each type (i.e., style, size, and finish) installed, but no fewer than two of each type.
 - 2. Service/Power Poles: One for every 10 of each type installed, but no fewer than one of each type.

1.07 SPARES

- A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. SPD Receptacles: [One for every 10] <Insert quantities> of each type installed, but no fewer than [two of each type] <Insert quantities>.
 - 2. SPD Receptacles With Replacement Surge Modules: [One for every 10] <Insert quantities> of each type installed, but no fewer than [two] <Insert quantities> of each type.
 - 3. Wall Plates: One for every 10 of each type (i.e., style, size, and finish) installed, but no fewer than two of each type.
 - 4. Service/Power Poles: One for every 10 of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, special purpose receptacles, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

2.02 MANUFACTURERS

- A. [Available]Manufacturers:
 - 1. Receptacles and Switches:
 - a. Eaton.
 - b. Hubbell Incorporated.

- c. Legrand.
 - d. Leviton.
 - 2. Multioutlet Assemblies:
 - a. Hubbell Incorporated.
 - b. Legrand.
 - 3. Service/Power Poles:
 - a. Hubbell Incorporated.
 - b. Legrand.
 - c. Panduit
 - d. Schneider Electric.
 - 4. Emergency Power Off Buttons:
 - a. Eaton.
 - b. GE Industrial.
 - c. Schneider Electric.
- B. In other Part 2 articles below, where manufacturers and device catalog numbers are included, the following additional requirements apply to product selection:
- 1. Product manufacturer and model numbers listed are to establish the quality of the wiring devices. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers listed in individual articles below, in addition to those listed in Paragraph "Available Manufacturers" above.
 - 2. Coordinate the proper suffixes in order to provide the correct color as specified below.

2.03 FINISHES

- A. Color:
- 1. Wiring devices connected to normal power systems: [Black] [Brown] [Gray] [Ivory] [White] [As selected by Architect] [<Insert color>] [Match existing devices], unless otherwise indicated or required by NFPA 70. Cover plates: [The same as the wiring device][As selected by the Architect][Match existing cover plates].
 - 2. Wiring devices connected to emergency power systems: Red [<select other color as required/desired>]. Cover plates: [The same as the wiring device][As selected by the Architect][Match existing cover plates] and engraved with "EMERGENCY POWER" with white filler in the engraving. Engrave the panelboard designation and circuit number serving the emergency device into the cover plate.
 - 3. Hospital grade receptacles: As specified above, with a green dot on its face.
 - 4. SPD devices: Blue [Black] [Brown] [Gray] [Ivory] [White] [As selected by Architect] [<Insert color>] [Match existing devices]. Cover plates: [The same as the wiring device][As selected by the Architect][Match existing cover plates].
 - 5. Isolated-Ground receptacles: Orange [As specified above], with an orange triangle on its face. Cover plates: [The same as the wiring device][As selected by the Architect][Match existing cover plates] and engraved with "ISOLATED GROUND" at the top with [white filler][<insert contrasting color>] in the engraving.

2.04 CONVENIENCE RECEPTACLES

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A.

- B. Duplex convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
 - 1. Basis of Design: Legrand 5362 duplex; similar for simplex.
- C. Duplex convenience receptacles: Commercial Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
 - 1. Basis of Design: Legrand CR20.
- D. Duplex tamper resistant convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
 - 1. Basis of Design: Legrand TR5362.
- E. Duplex tamper resistant convenience receptacles: Commercial Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
 - 1. Basis of Design: Legrand TR20.
- F. Duplex weather resistant convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
 - 1. Basis of Design: Legrand WR5862.
- G. Duplex weather resistant convenience receptacles: Commercial Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
 - 1. Basis of Design: Legrand WR20TRW.
- H. Twist-Locking type receptacles: NEMA L5-20R, 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, self-grounding.
 - 1. Basis of Design: Legrand L520-R.
- I. USB/duplex convenience receptacles: NEMA 5-20R, 125V, 20A, tamper resistant, 3-wire, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding; with integral USB charger having two ports, USB 2.0 compatible, 5VDC, 3A output (min).
 - 1. Basis of Design: Legrand TR5362USB.
- J. USB-charging-only convenience receptacles: 125V, 20A, 3-wire, grounding type, UL 1310 listed and labeled, smooth nylon face, side and back wired, self-grounding; with integral USB charger having four ports, USB 2.0 and 3.0 compatible, 5VDC, 4.2A output (min).
 - 1. Basis of Design: Legrand TM8USB4.
- K. Automatically Controlled receptacles: Where indicated on drawings, provide device type from other applicable category, along with marking for controlled receptacles as required by the current version of the NEC. In the case where the NEC is not applicable to the project, the device shall still be provided with this marking. In that case, the NEC is providing the standard for the marking and this specification is requiring it to be marked above and beyond the application of the code.

2.05 GFCI RECEPTACLES

- A. Ground fault circuit interrupter type receptacles: [Specification Grade][Hospital Grade] UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles downstream on the same circuit.
 - 1. Basis of Design: [Legrand 2097][Legrand 2097HG]
- B. Ground fault circuit interrupter type weather-resistant receptacles: [Specification Grade][Hospital Grade] UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A,

trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles downstream on the same circuit.

1. Basis of Design: [Legrand 2097TRWR][Hubbell GFR8300HTR]
- C. Ground fault circuit interrupter type tamper and weather-resistant receptacles: [Specification Grade][Hospital Grade] UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles downstream on the same circuit.
 1. Basis of Design: [Legrand 2097TRWR][Hubbell GFR8300HTR]
- D. Ground fault circuit interrupter with Blank Face: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles downstream on the same circuit.
 1. Basis of Design: Legrand 2085.
- E. Ground fault circuit interrupter with Isolated Ground: [Specification Grade][Hospital Grade] Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles downstream on the same circuit.
 1. Basis of Design: [Leviton 2095IGTRW][Leviton 2095IGHGTRW]

2.06 ISOLATED GROUND RECEPTACLES

- A. Isolated ground receptacles: Heavy Duty Specification grade [NEMA 5-20R][NEMA L5-20R], 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, furnished with a green pigtail connected to the grounding contact, and grounding contacts electrically isolated from the mounting strap.
 1. Basis of Design: Leviton 5362-IG Straight Blade; 2310-IG Locking
- B. Isolated ground receptacles: Commercial Specification grade NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, furnished with a green pigtail connected to the grounding contact, and grounding contacts electrically isolated from the mounting strap.
 1. Basis of Design: Legrand IG5362.
- C. Isolated ground receptacles: Hospital Grade NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, furnished with a green pigtail connected to the grounding contact, and grounding contacts electrically isolated from the mounting strap.
 1. Basis of Design: Legrand IG8300.

2.07 SPD RECEPTACLES

- A. SPD receptacles for 125V (150V maximum continuous operating voltage) service: NEMA 5-20R, 125V, 20A, self-grounding type, RFI/EMI noise filtering, UL 1449 listed & 489; equipped with LED indicator(s) and audible alarm.
 1. Basis of Design:
 - a. [Legrand 5362xSP; IG5362xSP w/Isolated Ground]
 - b. [Legrand 8300xSP; IG8300xSP w/Isolated Ground].
- B. Suppression module shall protect normal and common modes, with the following mode characteristics, and be suitable for ANSI/IEEE C62.41 A, B installations:
 1. Surge Protective Device Rating Type 3
 2. Peak Energy 240 joules minimum
 3. Peak Current 13,000A minimum
 4. UL 6kv/3000A (8/20 micro sec. wave form) Test 400V minimum (VPR)
 5. Response Time Approximately 5 nano-seconds

- C. Special Warranty: Manufacturer agrees to repair or replace SPD receptacles, or replaceable surge modules (if removable), that fail in materials or workmanship within 5 years from date of Substantial Completion.

2.08 SPECIAL/MISCELLANEOUS DEVICES

- A. Special purpose receptacles: Grounding type, UL listed with NEMA configurations as indicated below or on the Drawings.
1. Basis of Design: Legrand:
 - a. Dryer 14-30R 3864
 - b. Range 14-50R 3849
 - c. Switch/Receptacle Combo 671
 - d. Clock 5-15R S3733

2.09 SWITCHES

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide switches equivalent to those specified for 20A, but rated for 15A.
- B. Switches: Heavy Duty Specification grade, rated for 120/277V, 20A, back and side wired, and UL listed and labeled.
1. Basis of Design: Legrand:
 - a. 1 pole PS20AC1
 - b. 2 pole PS20AC2
 - c. 3-way PS20AC3
 - d. 4-way PS20AC4
- C. Pilot Light switches: 20A, single pole switch with [clear][red][green] lighted handle. Toggle shall be illuminated when the switch is in the "ON" position. Provide appropriate voltage option.
1. Basis of Design: Legrand:
 - a. 1 pole PS20AC1-XPL
 - b. 2 pole PS20AC2-XPL
 - c. 3-way PS20AC3-XPL
- D. Lighted Handle switches: 20A, single pole switch with [clear][white][ivory] lighted handle. Toggle shall be illuminated when the switch is in the "OFF" position. Provide appropriate voltage option.
1. Basis of Design: Legrand:
 - a. 1 pole PS20AC1-XSL
 - b. 2 pole PS20AC2-XSL
 - c. 3-way PS20AC3-XSL
- E. Key operated light switches: Same as standard light switches except toggle handle shall be operated by a factory provided key.
1. Basis of Design: Legrand:
 - a. 1 pole PS20AC1-L
 - b. 2 pole PS20AC2-L
 - c. 3-way PS20AC3-L
 - d. 4-way PS20AC4-L
- F. Switches for use with mechanically-held, electrically-operated lighting contactors: Single pole, double throw, momentary, center off switch, rated for 120/277V, and UL listed and labeled.

1. Basis of Design: Legrand 1251.

2.10 MULTI-OUTLET ASSEMBLIES

- A. Surface type "plug-in" strips: [Extruded aluminum][Steel][Polycarbonate] 3-wire, single circuit with single grounding type, 15A, 125V receptacles, pre-wired on [18-inch]<other spacing as required/desired for project> centers. Provide all fittings, devices, end closures, elbows, boxes and conduit entrance fittings as required for a complete installation.

1. Basis of Design:
 - a. [Hubbell ALU20]
 - b. [Hubbell 20GB]
 - c. [Hubbell Polytrak].

2.11 SERVICE/POWER POLES

- A. Service/Power Poles: [Extruded aluminum][Extruded aluminum with satin anodized finish][Steel][Steel with white enamel finish] raceway, internal barrier to separate power conductors from communications cables, ceiling trim plate, carpet/tile floor plate as required for floor material, a minimum of (2) pre-wired duplex receptacles connected to a junction box on the top of the pole, removable plate with knockouts for (2) telephone jacks and (2) data jacks, and a "pop-off" cover, removable without tools. Power poles shall be at least 6 inches taller than the ceiling but not less than 8'-6" tall.

1. Basis of Design:
 - a. [Legrand AMDTP-4]
 - b. [Legrand SMDTP-4].

2.12 EMERGENCY POWER OFF BUTTONS

- A. Push Button Operators: 30MM, watertight/oiltight, heavy duty, 600V maximum ac/dc, 10A continuous, momentary, non-illuminated, shrouded push button operator. Provide with 1 normally open and 1 normally closed contact block.

1. Basis of Design: Schneider 9001KR1RH13.

- B. Push/Pull Button Operators: 30MM, watertight/oiltight, heavy duty, 600V maximum ac/dc, 10A continuous, 2 position maintained, non-illuminated, push/pull button operator. Provide with 1 normally open and 1 normally closed contact block.

1. Basis of Design: Schneider 9001SKR9RH13.

- C. Break Glass Operators: 30MM, watertight/oiltight heavy duty, 600V maximum ac/dc, 10A continuous, push button operator that when disk is broken the operator is released to its open position.. Provide with 1 normally closed contact block, surface or recess mounted, NEMA 1, 4, 4X enclosure with integral break glass hammer and chain.

1. Basis of Design: Schneider 9001K15.

2.13 DUAL VOLTAGE SWITCH RELAY

- A. A normally-open, electrically-held relay that allows a single-pole switch to control loads operating at two different voltages (e.g., 120V and 277V); listed to UL Standard 916; installed in a 2-gang outlet box, with a voltage-separating barrier and plaster ring.

1. Basis of Design: LC&D, Acuity Brands GR 2001 DV, or approved equal.

2.14 REMOTE GROUND FAULT CIRCUIT INTERRUPTER (GFCI) DEVICES

- A. [Available]Manufacturers:

1. Hubbell
2. Littlefuse
3. North Shore Safety

- B. UL 943 Class A Ground Fault Circuit Interrupter (GFCI) device in NEMA 4X wet location enclosure, voltage, phase, and current rating as shown on drawings. UL 943. Device shall have power and fault status indication lights and manual test and reset buttons on exterior of enclosure. Device shall allow for reset as follows:
 - 1. Automatic reset: Allows power downstream as long as power is available and will allow power downstream upon restoration of lost power. Requires reset button be pressed if unit trips due to fault condition.

2.15 COVER PLATES

- A. Damp Location Weatherproof Receptacle Cover Plates: UL-listed Wet Location (cover closed, not in use); die-cast, gasketed (factory-installed) self-closing covers, for [horizontal] [or] [vertical] mounting [as indicated]:
 - 1. Basis of Design: Legrand [4511 horizontal][4512 vertical].
- A. Wet Location Weatherproof Receptacle Cover Plates (Outlet Box Hood): NEMA 3R weather resistant recessed or flush mount, die cast aluminum lockable cover. Configure cover for [horizontal] [or] [vertical] mounting of receptacle or as indicated otherwise. Back box must be suitable for conduit connections. Coordinate back box with wall depth.
 - 2. Basis of Design: Leviton [IUM1H-GY horizontal][IUM1V-GY vertical].
- B. Damp and Wet Location Weatherproof switch cover plates: Fabricated of cast aluminum or cast zinc, sealed water-tight and UL listed for wet locations.
 - 1. Basis of Design: Appleton FSK.
- C. Other locations: Single and combination types to match corresponding wiring devices and manufacturer of wiring devices specified herein.
 - 1. Plate securing screws: Metal with head color to match finish plate.
 - 2. Material for Finished Spaces: [Brushed stainless steel Type 302][Smooth plastic, minimum 0.10-inch thick. Refer to "Finishes" above for color.][High impact nylon, minimum 0.10-inch thick. Refer to "Finishes" above for color.].
 - 3. Material for Unfinished Spaces and surface mounted wiring devices: Galvanized steel.
 - 4. Masonry walls and oversized wall openings: Jumbo size plates with same material as indicated above.

PART 3 - EXECUTION

3.01 GENERAL

- A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the [Contract Administrator][Engineer].
- B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.
- C. Provide twist-locking type receptacles or other special type receptacles [where indicated][as scheduled] on the Drawings.

3.02 EXAMINATION

- A. Verify existing conditions prior to beginning work.
- B. Verify that outlet boxes are installed at proper height and are flush with the finished surface.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. [Verify that floor boxes are adjusted properly and are flush with the finished surface.]

- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. [Verify that openings in access floor are in proper locations.]

3.03 PREPARATION

- A. If required, provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from in and around outlet boxes.

3.04 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.
- C. Connect wiring devices by wrapping conductors around screw terminals. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box. Exception: Do not bond grounding terminals of isolated ground receptacles to the outlet box.
- E. Install devices shown on wood trim, cases or other fixtures symmetrically and, where necessary, set with the long dimensions of the plate horizontal, or ganged in tandem.
- F. Unless dimensioned otherwise, install wiring devices a minimum of 24 inches from the closest edge of any sink.
- G. Install switches with OFF position down.
- H. Install cover plates on all switches, receptacles, and blank outlets.
- I. Locate wiring devices so that the cover plate does not have to be cut to be installed.
- J. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.
- K. Install cover plates after the wall has been finished (painted, wall paper, etc).
- L. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
- M. Provide engraved nameplate on emergency off buttons.
- N. Provide ground fault circuit interruption capability for all 120V receptacles 50A or less and all 208/240V receptacles 100A or less in code required locations. Locations include, but are not limited to: bathrooms, kitchens/food prep areas, exterior locations and within 6' of sinks. Interruption capability can be achieved via a GFCI circuit breaker or a GFCI receptacle.
- O. Provide type and quantity of normally open and/or normally closed contacts for emergency off buttons to meet the sequence of operations shown.
- P. Install wiring devices shown back-to-back on a common wall offset a minimum of 12" horizontally to reduce sound transmission between rooms.
- Q. Provide Hospital Grade receptacles in, patient rooms, surgery rooms, special procedure rooms, exam rooms, treatment rooms, radiology rooms and other patient care and treatment areas. Provide specification grade receptacles in all other areas unless otherwise noted.
- R. Provide safety-type, tamper-resistant receptacles in psychiatric patient rooms. Provide tamperproof screws on faceplates of all wiring devices in psychiatric patient rooms.
- S. Provide safety-type, tamper-resistant receptacles in all areas where receptacles are mounted less than 5'-6" AFF and are easily accessible to children.

3.05 MOUNTING HEIGHTS

- A. Coordinate locations of outlet boxes provided under Division 26 Section "Common Work Results for Electrical".
- B. Unless noted otherwise, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.
 - 1. Receptacles:
 - a. General:
 - 1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.
 - 2) Where Installed horizontally, install neutral slot mounted at the top.
 - b. Above counters:
 - 1) Mount vertically.
 - c. Mechanical and electrical equipment rooms and janitors closets:
 - 1) Mount horizontally.
 - d. Garages:
 - 1) Wet location: Mount horizontally.
 - 2) Other locations: Mount vertically.
 - e. Weatherproof exterior receptacles:
 - 1) Mount horizontally.
 - f. GFCI receptacles: Same as general receptacles.
 - g. Isolated ground receptacles: Same as general receptacles.
 - h. SPD receptacles: Same as general.
 - i. Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.
 - 2. Switches:
 - a. Above counters: Same as for receptacles.
 - b. Concrete Block Walls: Dimension may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom of boxes are at block joints.
 - c. Walls with wainscoting: 6 inches minimum above wainscoting, but not exceeding 48 inches above finished floor.
 - 3. Multi-outlet assemblies:
 - a. [16 inches above finished floor][36 inches above finished floor][48 inches above finished floor][as indicated on the Drawings][6 inches above counter top]<other mounting height as required/desired>.
 - 4. Telephone/Data Outlet Boxes:
 - a. General: Match mounting height of adjacent wiring device listed above.
 - 5. Emergency Power Off Buttons and Break Glass Operators:
 - a. General: Match requirements of switches listed above.
 - b. Wall-mounted telephone: 40 inches above finished floor.

3.06 IDENTIFICATION

- A. Label all devices fed downstream of GFCI protected receptacles as "GFCI PROTECTED".
- B. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served, using:
 - a. Hot, stamped or engraved machine printing with [black] [white] [red]-filled lettering on face of plate.
 - b. Durable wire markers or tags inside outlet boxes.
 - c. Permanent-ink marker, hand-printed legibly, inside outlet boxes.
 - d. Adhesive film label, but with letter/number height of 1/4 inch, on face of plate.
 - e. Adhesive Film Label with Clear Protective Overlay, but with letter/number height of 1/4 inch, on face of plate, for exterior and damp/wet locations.

3.07 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
- D. Test all wiring devices for electrical continuity and proper polarity of connections.
- E. Test each GFCI receptacle device for proper operation.
- F. Correct wiring devices incorrectly installed.
- G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.08 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.09 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 26 2726

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SECTION 26 2816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Fusible switches.
- B. Non-fusible switches.
- C. Receptacle switches.
- D. Shunt trip switches.
- E. Molded-case circuit breakers (MCCBs).
- F. Molded-case switches.
- G. Enclosures.

1.02 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of enclosed switches, circuit breakers and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Power System Studies".

1.04 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.
- C. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
 - a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Detail enclosure types and details for other than NEMA 250, Type 1.

3. Include general arrangement drawing showing dimensions and weights of each assembled section.
4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
5. Detail short-circuits current rating of enclosed switch or circuit breaker assembly and overcurrent protective devices.
6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
7. Include time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit electronic files, in an SKM-compatible format.
8. Include schematic and wiring diagrams for power, signal, and control wiring.
9. Include nameplate legends.
10. Include list of materials.
- D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around enclosed switches and circuit breakers where pipe and ducts are prohibited. Show enclosed switch and circuit breaker layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- E. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.
- F. Qualification Data: For qualified testing agency.
- G. Field quality-control reports.
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- H. Manufacturer's field service report.
- I. Sample Warranty: For warranty.
- J. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.
- K. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Routine maintenance requirements for enclosed switches, circuit breakers and all installed components.
 2. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 3. Time-current curves; include selectable ranges for each type of overcurrent protective device.
 4. Features and operating sequences, both automatic and manual.
 5. Video recording of operation training and demonstration.
- L. Follow-up service reports.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

- B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- C. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Comply with NFPA 70.

1.06 PROJECT CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
- B. Environmental Limitations:
 - 1. Do not deliver or install enclosed switches and circuit breakers until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2010 m).
- C. Interruption of Existing Electric Service: Refer to Division 26 section "General Electrical Requirements"

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- B. Deliver enclosed switches and circuit breakers in sections or lengths that can be moved past obstructions in delivery path.
- C. Coordinate delivery of equipment to allow movement into designated space.
- D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.
- E. Handle and prepare enclosed switches and circuit breakers components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.08 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components and/or products of the enclosed switches and circuit breakers that fail in materials or workmanship within the specified warranty period.
- B. Warranty Period: Three years from date of Substantial Completion.

1.09 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Refer to Division 26 section "Fuses" for spare fuse requirements. At a minimum, include spares for the following:
 - a. Potential transformer fuses.
 - b. Control power fuses.
 - c. Fuses for fusible devices.
2. Indicating Lights: Four of each type installed.
3. Primary Switch Contact Lubricant: One container.
4. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

Available Manufacturers:

1. ABB Inc.
 2. Eaton.
 3. Schneider Electric.
 4. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Short Circuit Current Rating: 100,000 rms symmetrical amps when fuses applied.
- F. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 7. Lugs: [Mechanical] [Compression] type, suitable for number, size, and conductor material.
 8. Service-Rated Switches: Labeled for use as service equipment.
 9. Accessory Control Power Voltage: Remote mounted and powered; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc].
- G. Arc Flash Mitigation
1. Fuses, 1200 A and larger, shall have a clearing time of 0.07 seconds or less at the available arcing current, or shall be provided with an energy-reducing active arc flash mitigation

capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.

2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

2.02 NONFUSIBLE SWITCHES

- A. [Available] Manufacturers:
 1. ABB Inc.
 2. Eaton.
 3. Schneider Electric.
 4. Siemens Energy & Automation, Inc.
 5. <Insert manufacturer's name>.
- B. Type HD, Heavy Duty, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, [240] [600]-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 4. Auxiliary Contact Kit: [One] [Two] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 6. Lugs: [Mechanical] [Compression] type, suitable for number, size, and conductor material.
 7. Accessory Control Power Voltage: Remote mounted and powered; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc].

2.03 RECEPTACLE SWITCHES

- A. [Available] Manufacturers:
 1. ABB Inc.
 2. Eaton.
 3. Hubbell Inc.
 4. Schneider Electric.
 5. <Insert manufacturer's name>.
- B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: [240] [600]-V ac, [30] [60] [100] A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

- C. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: [240] [600]-V ac, [30] [60] [100] A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
- E. Receptacle: [Polarized, three-phase, [four-wire receptacle (fourth wire connected to enclosure ground lug)]] [five-wire receptacle (fifth wire connected to enclosure ground lug)]] [As indicated on the plans].

2.04 SHUNT TRIP SWITCHES

- A. [Available] Manufacturers:
 - 1. Eaton.
 - 2. Littelfuse, Inc.
 - 3. Mersen
 - 4. Siemens Energy & Automation, Inc.
 - 5. <Insert manufacturer's name>.
- B. General Requirements: Comply with [ASME A17.1,] UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from [integral control power transformer, with primary and secondary fuses,] <Insert source of control power> with a control power [transformer] [source] of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.
 - 2. Oiltight [red] [green] [white] [yellow] ON pilot light.
 - 3. Isolated neutral lug; [100] [200] percent rating.
 - 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 5. Form C alarm contacts that change state when switch is tripped.
 - 6. Three-pole, double-throw, fire-safety and alarm relay; [120-V ac] [24-V dc] coil voltage.
 - 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
- F. Arc Flash Mitigation
 - 1. Fuses, 1200 A and larger, shall have a clearing time of 0.07 seconds or less at the available arcing current, or shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
 - 2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

2.05 MOLDED-CASE CIRCUIT BREAKERS

- A. [Available] Manufacturers:
 - 1. ABB Inc.
 - 2. Eaton.
 - 3. Schneider Electric.
 - 4. Siemens Energy & Automation, Inc.
 - 5. <Insert manufacturer's name>.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I²t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- J. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: [Mechanical] [Compression] type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; [integrally mounted, self-powered] [remote-mounted and powered] type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Communication Capability: [Circuit-breaker-mounted] [Universal-mounted] [Integral] [Din-rail-mounted] communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring and Control."
 - 6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

8. Auxiliary Contacts: [One SPDT switch] [Two SPDT switches] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 9. Alarm Switch: One [NO] [NC] contact that operates only when circuit breaker has tripped.
 10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 11. Zone-Selective Interlocking: Integral with [electronic] [ground-fault] trip unit; for interlocking ground-fault protection function.
 12. Electrical Operator: Provide remote control for on, off, and reset operations.
 13. Accessory Control Power Voltage: [Integrally mounted, self-powered] [Remote mounted and powered]; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc].
- K. Arc Flash Mitigation
1. Circuit breakers, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
 2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

2.06 MOLDED-CASE SWITCHES

- A. [Available] Manufacturers:
1. ABB Inc.
 2. Eaton.
 3. Schneider Electric.
 4. Siemens Energy & Automation, Inc.
 5. <Insert manufacturer's name>.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
1. Standard frame sizes and number of poles.
 2. Lugs: [Mechanical] [Compression] type, suitable for number, size, trip ratings, and conductor material.
 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 6. Auxiliary Contacts: [One SPDT switch] [Two SPDT switches] with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
 7. Alarm Switch: One [NO] [NC] contact that operates only when switch has tripped.
 8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
 9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.

10. Electrical Operator: Provide remote control for on, off, and reset operations.
 11. Accessory Control Power Voltage: [Integrally mounted, self-powered] [Remote mounted and powered]; [24-V ac] [120-V ac] [208-V ac] [240-V ac] [6-V dc] [12-V dc] [24-V dc].
- D. Arc Flash Mitigation
1. Circuit breakers, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
 2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

2.07 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. [Kitchen] [Wash-Down] Areas: NEMA 250, Type 4X, stainless steel.
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 6. Hazardous Areas Indicated on Drawings: NEMA 250, [Type 7][Type 9].

2.08 IDENTIFICATION

- A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine enclosed switches and circuit breakers before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.
- B. Examine areas, surfaces, substrates, and elements to receive enclosed switches and circuit breakers with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
1. Verify that field measurements are as indicated.
 2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine roughing-in of conduits and grounding systems to verify the following:
1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install enclosed switches and circuit breakers and accessories in accordance with manufacturer's instructions.

- B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."
- D. Wall-Mounted Switches and Circuit Breakers: Install enclosed switches and circuit breakers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For enclosed switches and circuit breakers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Floor-Mounted Switches and Circuit Breakers: Install enclosed switches and circuit breakers on concrete bases.
 - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of enclosed switches and circuit breakers unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
 - 2. Anchor enclosed switches and circuit breakers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Seismic Controls for Electrical Systems."
 - 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - 4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 6. Install anchor bolts to elevations required for proper attachment to enclosed switches and circuit breakers.
- F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- G. Mount equipment plumb and rigid without distortion of enclosure.
- H. Install fuses in fusible devices.
- I. Comply with NECA 1.
- J. Where installed on either side of a VFD, provide one normally open and one normally closed auxiliary contacts interlocked with the VFD.

3.03 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.04 IDENTIFICATION

- A. Equipment Nameplates: Label each section with equipment nameplate.
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- C. Diagrams and Instructions:
 - 1. Engraved, Laminated Acrylic or Melamine Label. Mount on front of equipment.
 - a. Operating Instructions: Printed operating instructions for switches and circuit breakers, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.
- D. Warning Labels: Label equipment with a warning label in accordance with NFPA 70 and NFPA 70E.
 - 1. Exception: Do not install NFPA 70 working clearance requirements on enclosed switches and circuit breakers in finished spaces.

3.05 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.06 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.07 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges and protective relay trip characteristics as specified in Division 26 Section "Power System Studies."

3.08 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing: Engage a qualified testing agency to perform the following field quality-control tests and inspections:
- C. Testing: Perform the following field quality-control tests and inspections:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.
- D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- E. Acceptance Testing Preparation:
 - 1. After installing equipment but before equipment is energized, test for compliance with requirements.
 - 2. Verify that grounding system at the equipment tested at the specified value or less.
 - 3. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 4. Test continuity of each circuit.

- F. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
 - 2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 - 5. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- G. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.
- H. Infrared Scanning: Perform the following infrared scan tests and inspections and prepare reports:
 - 1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - 2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - 3. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- I. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
 - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the main incoming section of each service entrance equipment. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 - 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Rebalance loads.
 - b. Prepare written request for voltage adjustment by electric utility in accordance with Division 26 section "Provisions for Electric Utility Service".
- J. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- K. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.09 DEMONSTRATION

- A. [Engage a factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain equipment, overcurrent protective devices,

instrumentation, and accessories [, and to use and reprogram microprocessor-based trip, monitoring, and communication units].

- B. Video record demonstrations presentation for Owner's records.

END OF SECTION 26 2816

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SECTION 26 5100
INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Included in the work of this section are labor, material, and appurtenances required to complete the work of this Section as specified herein, including, but not limited to:
 - 1. Interior light fixtures, lamps, LEDs, reflectors, lenses or faceplates, transformers, drivers and power supplies (includes exterior light fixtures normally installed on exterior surfaces of buildings).
 - 2. LED Emergency Driver
 - 3. Exit signs.
 - 4. Emergency lighting units.
 - 5. Emergency Lighting Mini-Inverter.
 - 6. LED Replacement Lamps
 - 7. LED Retrofit Luminaire Conversion Kits
 - 8. Light fixture supports.

1.02 DEFINITIONS

- A. CCT: Correlated color temperature
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. IC Rated: Rated for direct contact with insulation.
- E. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs
- F. LED: Light Emitting Diode
- G. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.
- H. LED Module or LED Light Engine: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.
- I. LER: Light fixture (Luminaire) efficiency rating.
- J. Light Fixture: Complete light fixture, including driver housing if provided.
- K. LPD: Lighting power density.
- L. RCR: Room cavity ratio.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.
- B. Coordinate layout and installation of light fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including, but not limited to, HVAC equipment, fire-suppression system, and partition assemblies. Contractor shall arrange his installation in proper relation to other work so that there shall be no interference, damage or delay to other trades' work
- C. Give ample notice of any special openings or rough-in work required for placing electrical/lighting work so as to avoid cutting or removal of completed work.

- D. Where work of this Section is to be flush or concealed, install it so it does not project beyond finished lines of walls, ceilings or floor surface.
- E. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

1.04 SUBMITTALS

- A. General:
 - 1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with SUBSTITUTIONS paragraph in Part 1 of this specification section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.
 - 2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
 - 3. Prepare portfolios from manufacturer's standard specification sheets, and include the fixture tag indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.
 - 4. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
 - 5. Modifications to fixtures shall be in accordance with Contract Administrator's comments.
- B. Product Data: For each type of light fixture, collated and bound in sets, and arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Summary page with the following for each light fixture type
 - a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
 - b. Light fixture driver or auxiliary device manufacturer, number and type.
 - 2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.
 - a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, fixture efficacy and/or efficiency, and verification of indicated parameters.
 - b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
 - 1) Include MacAdam ellipse step information for:
 - a) All interior light fixtures
 - b) Exterior luminaires installed on exterior building surfaces specified with 80 CRI or greater.
 - 3. Light fixture mounting details, including non-standard outlet boxes.
 - 4. Construction of light fixture housing and door (if applicable).
 - 5. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.
 - 6. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.
 - a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.

7. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, drivers, and accessories identical to those indicated for the light fixture as applied in this Project.
 - a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
8. Emergency driver cut sheet: Descriptive cut sheets providing physical description of emergency drivers for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.
- C. Shop Drawings: Show details of non-standard or custom light fixtures. Indicate dimensions, finish color, including, but not limited to, custom color, weights, methods of field assembly, components, features, accessories, and modifications. Scaled documents shall be provided for custom fixtures.
- D. Submittal Schedule
 1. Within 30 days of Division 26 contractor award, shop drawings covering all light fixtures within this section shall be forwarded to Contract Administrator to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.
 2. Within 15 days of "approved" and "approved as noted" shop drawings, contractor shall forward to Contract Administrator a guaranteed ship date for each specified fixture.
 3. Within 15 days after contractor's receipt of "reject and resubmit" or "not approved" shop drawings, contractor shall provide Contract Administrator with resubmitted shop drawings for only those fixtures deemed unacceptable.
 4. Contractor is responsible to call to the attention of the Contract Administrator any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures.
- E. Control Wiring
- F. Coordination Drawings: Refer to architectural reflected ceiling plans or details for exact location of light fixtures; engineering documents shall not be referenced for exact fixture positions. Contractor shall check and verify dimensions and details on drawings before proceeding with the work. If any question arises about the true meaning of drawings, refer the matter to the Contract Administrator, whose decision is final. In no case proceed with work with any uncertainty. Architectural documents shall show and coordinate with assistance from installers of items involved:
 1. Light fixtures.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems for light fixtures will be attached.
 4. Other items in finished ceiling including the following:
 5. Air outlets and inlets.
 6. Speakers.
 7. Sprinklers.
 8. Smoke and fire detectors.
 9. Occupancy sensors.

- 10. Access panels.
- 11. Perimeter moldings.
- G. Samples for Verification: For products designated for sample submission in Light Fixture Schedule, or at the request of Owner or Contract Administrator. Each sample shall include lamps, LEDs, and drivers. Sample shall be exact light fixture intended to be supplied for the project and equipped with 120-277V universal voltage and 120V cord and plug. Provide with pendant or wall support system if appropriate.
- H. Qualification Data: For agencies providing photometric data for light fixtures.
- I. Field quality-control test reports.
- J. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation and maintenance manuals.
- K. Warranties: Special warranties specified in this Section.

1.05 SUBSTITUTIONS

- A. Refer to Division 26 Section "General Electrical Requirements".
- B. Prior to the Bid Date, substitutions will not be considered unless the Contract Administrator has received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and complete Product Data for the proposed substitute, as defined in SUBMITTALS above, and all other information necessary for an evaluation. Provide interior point-by-point photometric calculations, under both normal and emergency lighting conditions, as applicable, if required by the Engineer. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.
- C. During the Bid
 - 1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.
 - 2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:
 - a. Agents can group only specified fixtures they represent, and
 - b. Only represent in the region where the specification originated, and
 - c. Exclude all fixtures outside their represented lines from the MLP, and
 - d. Sole-sourced (proprietary) light fixtures shall not be included in the MLP.
 - 3. Packaging of light fixtures will not be considered nor approved. Packaging is defined as: distributor(s) providing a single price for a light fixture package made up of specified and non-specified light fixtures. Any submittal package containing non-specified light fixtures or inclusion of lighting control systems will be immediately rejected in its entirety.
- D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Contract Administrator.
- E. During the construction period, no substitutions shall be considered if product delay is due to contractor's failure to order products in a timely manner after presentation of fixture schedules and specifications. Additional costs associated with air freight or special factory runs to meet schedule due to contractor's error shall be at the expense of contractor.
- F. The Contract Administrator has the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with NFPA 70.
- C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- D. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- E. Regulatory Agencies: Provide fixtures conforming to nationally- or internationally-recognized accredited testing agencies, such as U.S., ETL, ARL, or others in acceptance with local code enforcement policy.
- F. Electrical Components and Devices: Provide only fixtures that comply with National Electric Code (NEC), and in particular to Section 410. All ceiling recessed fixtures, whether indicated in a catalog number or not, shall be equipped with an integral thermal protection device.
- G. Light fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard in accordance with NEC or other regulatory agency as required by project location and Owner's insurance company.
- H. Mockups: Provide interior light fixtures for room or module mockups, complete with power and control connections.
 - 1. Obtain Contract Administrator's approval of fixtures for mockups before starting installations. Costs shall not be added to the base bid if Owner or Contract Administrator does not approve mockup.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work and documenting of final conditions.
 - 3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 WARRANTY

- A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Special Warranty paragraph in this section. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.
- B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.
- C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.
 - 1. LED Luminaires, including LED modules, arrays and drivers: Five years.
 - 2. LED Lamps: Three years.

- D. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Emergency Lighting Unit Batteries: <Insert number> years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining coverage years.
 2. Warranty Period for LED Emergency Driver] Batteries: <Insert number> years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining coverage years.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Additional light fixtures and accessories as scheduled on the Drawings.
- B. Where light fixtures are specified with tamper proof hardware, provide the Owner with three tools for each different type of hardware.

1.09 SPARES

- A. Furnish spare materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Battery and Charger Data: One for each emergency lighting unit.
 4. LED Drivers: 2 for every 100 of each type and rating installed. Furnish at least one of each type.
 5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS AND MATERIALS

2.01 GENERAL

- A. Manufacturers
1. In Light Fixture Schedule, the following requirements apply to product selection:
 - a. Basis-of-Design Product: The design for each light fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified that meets or exceeds performance characteristics of the named product.
- B. Light Fixtures and Components
1. Provide light fixtures as shown on the drawings and/or specified. This shall include all lamps, material and labor to securely hang light fixtures, clean them and make them completely ready for use. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures. Provide additional tie wires connected to structure to conform to applicable seismic requirements where required.
 2. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.
 3. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures. Manufacturer of recessed fixtures shall provide mounting brackets suitable for connection to ceiling system structure. Modifications to standard mounting brackets shall be coordinated

with contractor and delivered with fixture so that no delays to product delivery shall be allowed.

4. Metal Parts: Free of burrs and sharp corners and edges.
5. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
6. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
7. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - a. White Surfaces: 85 percent.
 - b. Specular Surfaces: 83 percent.
 - c. Diffusing Specular Surfaces: 75 percent.
 - d. Laminated Silver Metallized Film: 90 percent.
8. Plastic Diffusers, Covers, and Globes:
 - a. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 1) Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - 2) UV stabilized.
 - b. Glass: Annealed crystal glass, unless otherwise indicated.
9. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
10. Fixture Finishes:
 - a. Apply fixture finishes after fabrication in a manner that assures a durable wear-resistant surfacing. Give exposed metal surfaces (brass, bronze, aluminum and others) and finished castings, except chromium-plated or stainless steel parts, an even coat of high-grade meth/acrylate lacquer or transparent epoxy.
 - b. For corrosive or salt water environments, manufacturer shall provide fixtures with low copper/zinc cast aluminum (AB-47100 aluminum with less than 0.6% copper – classified for corrosive areas) housings to prevent salts from “pitting” aluminum housing. Manufacturer shall provide, in addition to or in lieu of, AB-47100 aluminum, ion added or pre-anodized polyester powder cast finish for “marine grade” applications. Manufacturer shall otherwise provide all stainless steel housing in conjunction with stainless steel hardware.
 - c. Recessed downlights in corrosive or salt water interior environments shall be equipped with a “natatorium” finish comprised of a zinc-chromated and phosphated process, then powder-coated on the exterior of the housing.
11. Reflectors:
 - a. Provide aluminum reflectors or reflecting cones for downlight style fixtures comprised of #12 aluminum reflector sheet, 0.57 inch (15 gauge) or heavier and free of tool-making indentations, including spinning lines caused by assembly techniques. All reflectors shall be of first-quality, anodized finish :Alzak” with specular or semi-specular finish and color as selected. Provide specular reflectors with no apparent brightness above 45 degrees from Nadir and semi-specular, diffuse reflectors with no apparent brightness above 75 degrees from Nadir.

12. Mounting hardware and trims:
 - a. Coordinate as need to suit ceiling conditions.
 - b. Light fixtures near or in contact with insulation shall comply with code.
 - c. Maintain a 3" minimum working clearance between non-IC rated light future housings and insulation on all adjacent ductwork, piping, walls and ceilings.
13. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - a. Label shall include the following lamp, LEDs, and driver characteristics:
 - 1) "USE ONLY" and include specific lamp or LED type.
 - i) LED type, wattage, beam angle (if applicable) for LED luminaires. Indicate maximum allowed wattage.
 - ii) CCT and CRI for all luminaires.
14. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by latest version of MIL-STD-461. Fabricate light fixtures with one filter on each driver or LED module indicated to require a filter.
15. Emergency lights and exit signs with integral battery back-up shall be connected to a separate unswitched conductor bypassing all other controls and contactors. Exit signs shall not be switched. Allow battery to charge for a minimum of [48] hours before light level testing. In order to prevent battery damage, do not turn off power for extended periods of time after the emergency light has been powered.

2.02 LED EMERGENCY DRIVER

- A. Internal Type: Self-contained battery, charger, and electronic circuitry, factory mounted within light fixture body and compatible with driver. Comply with UL 924.
 1. Emergency Connection: Provide wattage as scheduled on drawings to an LED load. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture driver.
 2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 3. Battery: Sealed, high-temperature, maintenance-free, nickel-cadmium or lithium ion type. The batteries shall be of suitable rating and capacity to supply and maintain at not less than 87 1/2 percent of the nominal battery voltage for the total lamp load associated with the unit for a period of at least 1 1/2 hours, or the unit equipment shall supply and maintain not less than 60 percent of the initial emergency illumination for a period of at least 1 1/2 hours.
 4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 5. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
- B. External Type: Self-contained battery, charger, and electronic circuitry, compatible with driver, remote mounted from light fixture. Comply with UL 924.

1. Emergency Connection: Provide wattage as scheduled on drawings to an LED load. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture driver.
2. Battery: Sealed, high-temperature, maintenance-free, nickel-cadmium or lithium ion type. The batteries shall be of suitable rating and capacity to supply and maintain at not less than 87 1/2 percent of the nominal battery voltage for the total lamp load associated with the unit for a period of at least 1 1/2 hours, or the unit equipment shall supply and maintain not less than 60 percent of the initial emergency illumination for a period of at least 1 1/2 hours.
3. Charger: Fully automatic, solid-state, constant-current type.
4. Housing: NEMA 250, Type 1 enclosure.
5. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
6. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
7. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.03 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free. Battery chemistry type shall be appropriate for installed environment.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.04 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free. Battery chemistry type shall be appropriate for installed environment.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
 8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.05 DRIVERS FOR LED LUMINAIRES

- A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:
1. Sound Rating: A.
 2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 4. Power Factor: 0.90 or higher at full load.
 5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
 6. Driver shall operate with maximum sustained variations of +/-[10] <Insert value>% input voltage and frequency with no damage to driver.
 7. Driver output shall be regulated to maximum +/- 5% published load range or requirements of downstream LED fixture.
 8. LED Current Crest Factor: 1.5 or less.
 9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
 10. Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.
 11. Meets EN610000 for input harmonics.
 12. ROHS Compliant.

B. Dimming Drivers:

1. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
 - a. Luminaires: 100 to 10 percent of rated lumens.
 - b. Lamps: 100 to 20 percent of rated lumens.
2. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and LED indicated.
4. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.06 EMERGENCY LIGHTING MINI-INVERTER

A. Manufacturer

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Bodine (by Signify),
 - b. Carpenter Emergency Lighting,
 - c. Chloride (by Signify),
 - d. Controlled Power Company,
 - e. Cooper Lighting,
 - f. DSPM, Inc,
 - g. Dual Lite,
 - h. Emergi-Lite,
 - i. Iota Engineering (Acuity Brands),
 - j. Inverter Systems, Inc (ISI),
 - k. Myers Emergency Power Systems,

B. Description – Self-contained uninterruptible or fast-transfer inverter designed for normal and emergency operation of connected lighting loads. Unit shall be capable of operating HID, incandescent, fluorescent, induction and LED fixtures with no break or interruption of illumination. UL 924 listed and meets NFPA 101, NFPA 70 and local codes.

1. Battery: Sealed, maintenance-free. Battery chemistry type shall be appropriate for installed environment. 68 deg F to 86 deg F optimum operating temperature.
2. Charger and Electronics: Fully automatic, thermal compensating variable rate battery charger. AC lockout feature, low battery voltage disconnect; DC overload, short circuit and brownout protection. 32 deg F to 104 deg F electronics operating temperature.
3. Operation: Inverter shall allow connected emergency lighting fixtures to be normally on. Upon loss of normal utility power, the emergency lighting fixtures will be delivered emergency power for their full lumen output rating with no break (<2 ms) in illumination for a minimum of 90 minutes.
4. 120V, single phase input and output voltages. Input voltage shall match output voltage, and +/- 3% voltage regulation, 60 Hz.
5. Maximum remote mounting distance of 1000'-0".
6. Housing: Designed for surface mounting installation to floor or wall. 16 gauge steel housing with scratch-resistant powder coat paint finish..
7. Testing: Integral testing means by either manual test switch or self-testing, self-diagnostic with manual testing capabilities.

8. Onboard LED indicating lights for inverter status indication.
 9. Manufacturer's warranty or minimum 2 year warranty on electronics and battery and seven-year prorata warranty on battery, whichever is greater.
 10. Overload and short circuit protection on input and output of inverter. Circuit breakers or fusing on output side.
- C. Where wattage of inverter is different from Basis-of-Design manufacturer's selected wattage, provide quantity of inverters as required to meet design intent. If additional inverters are required, confirm additional equipment will fit within available space constraints.
- D. Where physical size of inverter is different from Basis-of-Design manufacturer, confirm equipment will fit within available space constraints.

2.07 LAMPS GENERAL

- A. Unless specific manufacturers and lamp types are called for in the Light Fixture Schedule, all lamps provided for this project shall be by the same manufacturer. Lamps shall be manufactured by:
1. Eiko
 2. General Electric
 3. Osram/Sylvania
 4. Philips
 5. Soraa
 6. Venture
- B. All lamps shall be new and shall be delivered to the project in manufacturer's original sealed package.
- C. Substitutions of specific lamp manufacturer as addressed in Fixture Schedule shall not be allowed. Costs associated with re-lamping due to non-compliance with specification, for both labor and material costs, shall be the sole responsibility of the contractor. For those fixtures with lamp included in fixture, contractor shall coordinate with manufacturer to ensure only approved lamp(s) is (are) installed. Lamp manufacturers indicated on Fixture Schedule are for reference. Where required, contractor shall coordinate with Owner regarding national purchasing agreement of specific lamp manufacturers. Purchasing of lamps, whether through competitive bidding of listed manufacturers or proprietary supply, shall be at the discretion of the Owner.

2.08 LED LAMPS AND LUMINAIRES

- A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 80 CRI minimum and [3000K][3500K][4000K] CCT.
- B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values or as indicated in the Light Fixture Schedule, whichever is more stringent. All LEDs used for same fixture type throughout the project to originate from same production bin.
- C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% maintained initial-rated lumens at average rated life of as follows:
1. LED lamps: 20,000 hours
 2. LED luminaires: 50,000 hours
- D. ROHS compliant
- E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Cree, Nichia, Osram or Xicato LEDs; additional manufacturers may be considered however the Contract Administrator or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

2.09 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

- A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system. Where equipment is not indicated as plenum rated, provide an additional enclosure for the device(s) suitable for the installed environment.

2.10 LED REPLACEMENT LAMPS

- A. Light-emitting diode (LED) self-ballasted lamps listed as complying with UL 1993; intended for replacement of existing lamps of other light source types, including but not limited to, incandescent, fluorescent, and high intensity discharge (HID); suitable for installation in luminaire to be retrofitted.

2.11 LED RETROFIT LUMINAIRE CONVERSION KITS

- A. Light-emitting diode (LED) retrofit luminaire conversion kits, including but not limited to LED lamps and arrays, control modules, drivers, power supplies, wiring, lampholders, brackets, wire connectors, reflectors, and diffusers, intended for replacement of existing light sources in existing luminaires; listed as complying with UL 1598C; suitable for installation in luminaire to be converted.

2.12 LIGHT FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.13 TRANSFORMERS FOR LOW VOLTAGE FIXTURES

- A. Provide transformers to low voltage lamps which are suitable for the electrical characteristics of the supply circuits to which they are to be connected. For remote electronic or magnetic transformers, contractor shall remote transformers so as to reduce voltage drop. For 25 amp low-voltage linear systems, contractor shall not daisy-chain 25A loaded runs together. Contractor shall provide home-run from end of run to remote transformer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Light Fixtures: All work shall be executed to present a neat appearance. Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- C. Temporary Lighting: If it is necessary, and approved by Contract Administrator, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

- D. Support for Light Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from light fixture corners.
 - 2. Support Clips: Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on light fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Suspended Light Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Provide suitable connectors or collars to connect adjoining units to appear as a continuous unit.
 - 4. Decorative pendant mounted light fixtures
 - a. Provide cord and/or stem lengths to match elevations above finished floor as indicated on architectural elevations. If architectural elevations do not indicate suspension heights, coordinate with Contract Administrator to determine final suspension heights. Regardless, contractor shall not field cut pendants or order rigid stems without elevation approval from Contract Administrator. Pendant suspensions on electrical documents are for reference only.
 - 1) Cord-mounted: Manufacturers shall supply luminaires with flexible, field cutting cords. Contractor shall field cut cords as required.
 - 2) Field-cuttable, rigid-stem mounted: Manufacturers shall supply luminaires with field cutting rigid stems. Contractor shall field cut stems as required.
 - 3) Factory-cut rigid stem mounted: Contractor shall provide rigid stem dimensions to the manufacturer as required.
 - b. Junction boxes used to feed light fixtures shall be covered by manufacturer supplied canopy plates.
- F. Installation within non-standard ceilings, including, but not limited to, wood and metal ceilings.
 - 1. For recessed downlight light fixtures, specification is based on standard throats to accommodate ceiling thicknesses of 3/4" or less. If non-standard ceiling (such as wood, thickened gypboard ceilings and metal plank type) require throats greater than 3/4", modifications to manufacturer's standard 3/4" throat shall be determined by Contract Administrator and Contractor prior to shop drawing submission.
 - 2. For light fixtures recessed into metal ceilings, rigidly support light fixture to ensure that trim fits flush with ceiling plane.
- G. Manufacturer shall supply contractor with a complete list of component elements to comply with design intent for either 20-amp (flexible low voltage track systems or line voltage track) or 50-amp bus bar track systems. Contractor shall install track systems based on design requirements outlined herein or Light Fixture Schedule.
- H. Connect wiring according to Section "260519 - Low-Voltage Electrical Power Conductors and Cables."
- I. Through wiring of recessed light fixtures, in suspended ceilings, is not permitted. Connect each light fixture by a whip to a junction box. The whip shall be of sufficient length to allow the light fixture to be relocated within a 6-foot radius.

- J. Wall Mounted Light fixtures
 - 1. Unless otherwise noted, conceal all raceways and back boxes for wall mounted light fixtures. Coordinate all wall-mounted light fixtures with interior elevations. Where specific elevations or dimensions are not indicated, verify the correct location with Contract Administrator prior to installation. Contractor shall supply structure to support weight of fixture.
- K. Contractor shall construct light coves according to architectural details. Contractor shall ensure, unless otherwise directed, that top of fixture lamp is flush with top of cove lip. Contractor shall provide blocking as needed under fixture to ensure stated requirement.
- L. Auxiliary Devices for low voltage and LED Fixtures
 - 1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
 - 2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.
 - 3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
 - 4. Properly support remote lighting devices, including transformers, power supplies, and drivers, per Code and manufacturer's recommendations.

3.03 DIMMING

- A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:
 - 1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
 - 2. 2-Wire dimming – two line voltage conductors plus ground
 - 3. 3-Wire dimming – three line voltage conductors (1 for control and two for power) plus ground
 - 4. DALI – two low voltage conductors and two line voltage conductors plus ground
 - 5. Proprietary digitally addressable – as required per the manufacturer
 - 6. DMX – two line voltage conductors plus ground and DMX cabling
- B. Coordinate light fixture and control device dimming types for compatibility.

3.04 COORDINATION

- A. Light fixtures shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings for exact locations.
- B. Coordinate the installation and location of light fixtures with other work and all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.
- C. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.
- D. Coordinate final light fixture locations in walk-in coolers and freezers with refrigeration coils and other trades.
- E. Wall-Mounted Light fixtures
 - 1. Coordinate all wall-mounted light fixtures with the architectural features of the building. Where specific elevations or dimensions are not indicated, verify the correct location with the Contract Administrator prior to beginning any work.

3.05 ADJUSTING

- A. Contractor shall adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Contract Administrator.
- B. At the time of substantial completion, aim all track lights, flood lights, spot lights, and other fixtures requiring aiming per the Contract Administrator's direction. Contractor shall make provisions for supplying all scaffolds, lifts, and other tools and equipment as required.
- C. Where required, focusing shall be done during hours of darkness. Upon notification by contractor that all fixtures are correct as per shop drawings and functioning, that specified lamps have been verified, lighting designer or Contract Administrator shall coordinate with contractor as to a mutually agreed upon time to complete focusing. Failure of contractor to notify Contract Administrator during substantial completion will result in failure to comply with specifications.

3.06 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- C. Upon completion of the installation of light fixtures, and after building circuits have been energized, energize lighting branch circuits to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. At the time of final acceptance of this project by the Owner, ensure that all lamps are in working order and all light fixtures are fully lamped.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.07 POST-CONSTRUCTION ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
 - 1. Adjust aimable luminaires in the presence of Contract Administrator or lighting designer.

END OF SECTION 26 5100

SECTION 274116
AUDIO-VISUAL COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This section pertains to the audio-visual communication system to be furnished and installed in the Wyoming State Capitol Acoustic Treatments Design. (C1117A).
- B. It is the purpose of this specification to require the furnishing of highest-quality materials, equipment, and workmanship. The work shall be in accordance with this specification and in conformity with the designs, layouts, and descriptions shown on the drawings.
- C. Any and all structural, mounting, or rigging details on the drawings are shown for concept only. It shall be the responsibility of the Systems Contractor to employ the services of a qualified Structural Engineer to be responsible for the design of the details to be employed. Stamped shop drawings and calculations of all such details shall be submitted to the Architect for review.
- D. Unless noted otherwise on the drawings, the work shall include everything necessary or incidental to complete the installation EXCEPT wire raceway, conduit, cable trays, fittings, outlet boxes, pull boxes, terminal cabinets, 120-volt AC power circuits, and insulated ground cables. Such excluded equipment shall be furnished and installed by the project Electrical Contractor. The Systems Contractor shall furnish all necessary information to the Electrical Contractor to ensure that a proper audio conduit system will be installed.
- E. The Systems Contractor shall furnish all loudspeaker back boxes (loudspeaker enclosures) and, where such enclosures are shown to be connected directly to conduit, the Systems Contractor shall furnish the enclosures to the Electrical Contractor for installation under the electrical contract.
- F. The Systems Contractor shall cooperate with all other contractors engaged in this project and shall coordinate the installation of the audio-visual communication systems so that all work will proceed in a manner which is in the best interests of the Owner.

1.02 EXISTING CONDITIONS

- A. This facility is an existing structure. It shall be the responsibility of each bidder to verify all conditions and dimensions which pertain to this work.
- B. The Systems Contractor shall verify the location, the operating conditions, and the conditions affecting the proposed work. Items to be verified by the Systems Contractor shall include, but not be limited to, reuse of existing equipment and access requirements to install all concealed components of the work. Bids submitted shall account for and include, but not be limited to, any and all work associated with providing concealed components (such as cable or conduits) and the complete restoration of all existing building components that are disturbed, modified, or dismantled in the process of installing the concealed components of the work.
- C. The existing audio-visual communication system shall remain operational in occupied areas throughout the installation, testing, and equalization of the new or reused/relocated components associated with this project. The Systems Contractor shall coordinate the installation of the new and reused/relocated audio-visual communication system components with the Architect and/or Owner to provide complete and operational systems for all operational facilities during and after each phase of the project and minimize disruption to occupants.
- D. Unless specifically noted on the drawings, existing audio-visual communication system components and wiring shall not be damaged or disturbed. Any such damage to the existing system shall immediately be reported to the Architect and Acoustical Consultant, and if caused by the Systems Contractor, shall be repaired or replaced by the Systems Contractor as

approved by the Architect at no additional cost to the Owner. The Systems Contractor shall notify the Architect and the Acoustical Consultant prior to conducting installation work within the existing audio equipment room.

- E. Existing audio-visual communication system conduit in the facility may be reused where appropriate for the new audio-visual communication system, subject to the following stipulations: 1) the existing conduit is installed in locations and using methods consistent with the drawings and these specifications; 2) existing circuits can remain installed and operational until no longer required as indicated in these specifications; and 3) the conduit permits segregation of circuits according to type per these specifications.
- F. Any existing equipment described in these specifications or shown on the drawings to be removed and not reused shall be turned over, undamaged, to the Owner.
- G. As indicated on the drawings or defined herein, some existing audio-visual communication system equipment shall be reused with the new system. Prior to reuse of this equipment, the Systems Contractor shall verify that the equipment is in proper operating condition and shall provide brackets or shelf units as required for rack-mounting existing equipment. The Systems Contractor shall report to the Acoustical Consultant any existing equipment problems and shall also provide pricing to repair or replace the inoperable existing equipment. Existing equipment to be reused includes the following:
 - 1.
 - 2.
 - 3.

- H. ****Special Existing System Coordination Items****

1.03 DEFINITION OF TERMS

- A. The term "Owner" shall refer to State of Wyoming; 200 W 24th St.; Cheyenne, WY 82001.
- B. The term "Architect" shall refer to Treanor; 1755 Blake Street; Denver, CO 80202; phone (303) 298-4700.
- C. The term "Acoustical Consultant" shall refer to AVANT ACOUSTICS, LLC; 15323 W. 95th Street; Lenexa, KS 66219; phone (913) 888-9111.
- D. The term "Systems Contractor" shall refer to the person, persons, or company who or which contracts for the performance of the audio-visual communication system work specified herein.

1.04 CONTRACTOR QUALIFICATIONS

- A. The Systems Contractor must be a "Systems Contractor" who regularly engages in the furnishing and installation of commercial and industrial audio-visual communication systems.
 - 1. The Systems Contractor shall have completed at least three (3) projects in the last five (5) years of similar size and scope.
- B. The Systems Contractor must maintain a suitably staffed and equipped service organization and must regularly offer maintenance services for systems of this type and size.
- C. The Systems Contractor shall be able to respond to on-site maintenance service requests within 24 hours during the warranty period described in section 3.07 System Warranty and Maintenance at the end of these specifications.
- D. The Systems Contractor is required to employ staff, to be engaged in this project, with the following certifications:
 - 1. Certified Technology Specialist - Installation.

- E. As part of the bid submittal, Systems Contractor shall submit appropriate information to demonstrate to the satisfaction of the Owner, Architect, and Acoustical Consultant that the Systems Contractor has
 - 1. Completed similar projects as described above;
 - 2. Adequate plant and equipment to pursue the work properly and expeditiously;
 - 3. Ability to provide maintenance visits in the time window described above;
 - 4. Adequate staff with the required technical experience and certifications described above;
 - 5. Suitable financial status to meet the obligations of the work.
- F. Any other contractor, who intends to bid on this work as the prime contractor and does not otherwise meet the requirements of the "Contractor Qualifications" paragraph(s) above, shall employ the services of a "Systems Contractor" who does meet the requirements noted above and who shall furnish the audio and video equipment; shop fabricate the equipment racks and subassemblies; make all audio, video and control connections to equipment and equipment racks in the AV equipment room; make all connections to remote mixer controls and microphone connection panels; and continuously supervise the installation and connections of all audio-visual communication system cable and equipment.
- G. A subcontractor so employed as the "Systems Contractor" must be acceptable to the Architect and the Acoustical Consultant and shall be identified on the Bid Proposal Form.

1.05 SUBMITTALS

- A. The Systems Contractor shall submit electronic documents of the following Shop Drawings per the schedule listed below for review by the Architect and the Acoustical Consultant. Refer to the General and Special Conditions for additional requirements such as physical submittal copies.
 - 1. Prior to proceeding with the work:
 - a. A complete list of ALL equipment and materials which are to be furnished. Accompanying the list shall be equipment quantities and manufacturers' specification or cut sheets for all sound system equipment (e.g. microphones, audio program source equipment, power amplifiers, loudspeakers), audio-visual equipment (e.g. projectors, program source equipment, monitors, video processing equipment), AV control equipment (e.g. touchpanels, system controllers, interface/control cards), and any other MAJOR items of equipment.
 - 2. Prior to proceeding with respective portions of work:
 - a. Drawings indicating proposed nameplate nomenclature and arrangements for control panels, patch panels, connection plates, floor boxes, and nameplates prior to fabrication as described elsewhere in these specifications.
 - b. Detail drawings of proposed loudspeaker suspension including attachment methods, weights, suspension locations, and calculations approved by the Systems Contractor's Structural Engineer.
 - c. Detail drawings showing projector/projection screen/flat panel display/LED display mounting.
 - d. Detail drawings showing front panel layouts for all equipment racks and AV lecterns, prior to installation, reflecting equipment, and labels to be used.
 - e. Diagram drawings for AC power low-voltage control switching, indicating distribution and sequencing of AC circuits for both on and off cycles.
 - f. Control system layout.
 - g. Custom furniture and/or custom millwork.
 - h. Details and descriptions of any other aspect of the audio-visual communication system which must differ from the drawings due to field conditions or due to the selected equipment to be furnished.

3. As otherwise noted on the drawings and/or as noted herein.
- B. Approved shop drawings and equipment instruction brochures, including schematic diagrams for all amplifiers and other electronic devices, shall be present at the job site during the period set aside for final system test and equalization.
- C. Notebooks of operating instructions shall be prepared as described elsewhere in the specifications.

PART 2 - PRODUCTS

2.01 GENERAL

- A. It is the intention of these specifications to provide a complete and properly operating audio-visual communication system. The major items of equipment shall be furnished in the quantity indicated by the audio-visual communication system diagrams on the drawings or in the quantity as specified herein. (Refer to the Portable Equipment Quantity list at the end of the specifications.) However, any minor item of equipment or hardware that may not be specifically shown on the drawings or specified herein but required for proper audio-visual communication system operation or installation shall be furnished by the Systems Contractor.
- B. All equipment and material shall be new and shall be suitable for continuous operation.
- C. The latest version of all specified equipment shall be furnished by the Systems Contractor.
- D. In any case, where a specific specification has not been included herein or shown on the drawings for any item that is required, the Systems Contractor shall furnish only the best quality equipment or material consistent with the quality of other specified equipment and material.
- E. Where the specifications list several manufacturers for a particular major item of equipment such as power amplifiers or loudspeakers, the Systems Contractor shall supply all of that item of equipment from one manufacturer.

2.02 SUBSTITUTIONS

- A. Equipment substitutions will only be allowed with prior approval.
- B. Where a specific piece of equipment has been discontinued and/or replaced by a new model, submission of the new model or a suitable item as applicable may be required by the Acoustical Consultant for evaluation prior to acceptance.
- C. If substitute equipment is allowed by written consent, the Systems Contractor shall be completely responsible for the use of such equipment. The Systems Contractor shall replace all such equipment with equipment listed by type number in the specifications if there is any evidence of equipment instability or unsuitability.
- D. Costs of any required evaluation and testing of substitute equipment shall be paid by the Systems Contractor.
- E. Any use of substitute equipment shall be at no extra cost to the Owner.
- F. Proposed substitute equipment shall be specifically noted in submittals as "substitution" with a footnote stating the reason for the substitution.
- G. Offerors proposing to furnish an "or equal" product must furnish all descriptive material necessary to demonstrate the acceptability of such product. The Acoustical Consultant shall be the sole determiner as to whether the proposed "or equal" product is suitable for use in work based upon review of the descriptive materials furnished.

2.03 SYSTEM DESCRIPTIONS AND SUMMARIES

2.04 SOUND SYSTEMS

- A. Microphones

- B. Microphone Accessories
- C. Audio Source Equipment
- D. Audio Processing Equipment
- E. Audio Mixers
- F. Audio Distribution Equipment
- G. Power Amplifiers
 - 1. Audio input connections to all power amplifiers shall be made with 3-pin microphone type connectors, with spade lugs on barrier terminal strips, or with screw actuated pressure type terminal strips. Audio output connections to all power amplifiers shall be made with spade lugs on barrier strips, with double banana plugs, or with Neutrik "Speakon" type connectors. Connections with ¼-inch phone plugs will not be permitted.
 - 2. For all power amplifiers with front-panel controls and/or AC power switches, furnish custom clear acrylic plastic covers (or other approved method for preventing tampering). A separate plastic cover shall be installed over each power amplifier. Submit shop drawings indicating cover material, dimensions and mounting method.
- H. Loudspeakers and Accessories
 - 1. Only the latest versions of the loudspeakers in the above paragraphs shall be furnished. All loudspeakers provided for each type shall match in all respects.
 - 2. Loosely, but completely, fill each separate loudspeaker enclosure with lightweight glass fiber insulation, where not already provided by manufacturer's assembly.
 - 3. Verify available mounting depth and clearance at each loudspeaker or loudspeaker enclosure location. Where available depth is insufficient, furnish a reduced-depth version of the specified loudspeaker or enclosure (or alternate unit) as approved on shop drawings showing affected locations and proposed enclosure dimensions and clearances.
 - 4. Where loudspeakers are shown on the drawings to be installed above perforated metal panels (if any), do not provide/install loudspeaker baffle, and remove grilles. If required to minimize visibility through ceiling panels, paint enclosure/trim ring and all mounting hardware black. In such installations, loudspeaker assemblies that require the use of a baffle (grille) to attach the loudspeaker to the enclosure are not acceptable.
 - 5. Where loudspeakers are installed in exterior conditions, provide manufacturer's or custom gaskets, covers, sealant, or other accessories as required to ensure a weather-resistant installation. Use stainless steel enclosures and hardware to prevent rust in exterior conditions; use Type SO cable where exposed as specified herein.
 - 6. All loudspeakers and loudspeaker enclosures shall be supported from the building structure as designed by the Systems Contractor's structural engineer and as indicated on shop drawings submitted to Architect. Such devices installed into a T-bar/channel style ceiling shall have a load support tie-off to the building structure above and not rely on the ceiling support system for structural integrity.
 - 7. Where selected loudspeaker models are provided with line matching transformers that include power tap values that are different than the values shown on the drawings, use the available tap nearest to that shown on drawings. Indicate any such different power tap values on shop drawings submitted for review. If tap setting differences result in loads that exceed power amplifier capacity, provide additional power amplifier channel(s) and

circuits as required. Submit revised circuiting and equipment requirements with shop drawings for review.

8. Where required by local codes and/or the Authority Having Jurisdiction (AHJ), provide paging system loudspeakers that are rated for the intended use (e.g. compliant with UL-1480 and/or UL-2043).

- I. Production Intercommunication Systems
- J. Audio Accessories

2.05 AUDIO-VISUAL SYSTEMS

- A. Cameras
- B. AV Program Source Equipment
- C. Video Processing
- D. Video Distribution
- E. Video Monitors
- F. Video Projectors
- G. Audio-Visual Accessories

2.06 ETHERNET NETWORKS

- A. Network Equipment
 1. All UTP field circuits shall terminate to appropriately labeled punchdown terminations (patch panels or biscuit jacks) installed in the equipment racks. Use factory fabricated patch cables between all punchdown terminations and the switches, and between all rack mounted equipment and switches.

2.07 AV CONTROL SYSTEMS

- A. General
 1. As shown on the drawings and described in these specifications, the AV Control System installation work will include the following components:
 - a.
 - b.
- B. Touchpanels and Remotes
 1. Wired Touchpanels
 2. Wireless Touchpanels
 3. Wireless Remotes
- C. System Controllers
 1. Interface/Control Cards
 2. Television Controllers
- D. Software Applications
 1. Voting
 2. Scheduling

- E. Custom Programming

2.08 CABLE AND CONNECTORS

- A. Audio Cable
- B. Video Cable
- C. RF Distribution Cable
- D. Control Cable
- E. Data Communication Cable
 - 1. Unshielded Twisted Pair
 - 2. RS232
 - 3. RS422
 - 4. RS485
 - 5. Fiber Optic Cable

- F. Audio Connectors

- G. Video Connectors

2.09 EQUIPMENT RACKS, CABINETS, AND ACCESSORIES

- A. Equipment Racks and Cabinets
 - 1. Furnish small magnetic portable work light with LED bulb and gooseneck in each equipment rack.
 - a. Middle Atlantic LT-GN-WL; or
 - b. Approved equal.
 - 2. USB LED work light in the Stage Manager Console.
 - a. Middle Atlantic LT-GN-PL.
 - 3. Configure adjustable rack rails inside equipment racks as necessary for proper clearance for cable routing and front mounted controls.
 - 4. All racks shall be keyed alike if possible.
 - 5. All standard sized rack panels used to mount controls or connectors shall have formed edges. Rack panel mounting screws shall be as short as practical for equipment to be mounted (Middle Atlantic HPQ or similar).
 - 6. Any rack front panel details shown on the drawings are for concept only. Shop drawings are required indicating the exact equipment to be furnished. The exact size (larger or taller racks) and quantity of equipment racks is to be determined by the Systems Contractor based upon the exact equipment to be furnished. Verify all audio equipment room dimensions and conditions.
 - 7. Except as noted on the drawings, include a 1RU panel at the top of one equipment rack engraved with the logo and contact information of the Acoustical Consultant and the Systems Contractor.
 - 8. Except as noted on the drawings, allow 1¾-inch blank panel space at the top of each rack, minimum 3½-inch vent panel space at the bottom of each rack, and ventilation space (vent panels) between all equipment. Fill any empty rack space that is not near

equipment with blank panels. Except as noted on the drawings or for mounting switches or LED indicators, blank panels shall not be used between equipment.

9. Where applicable, install a brush grommet panel directly above equipment such as an Ethernet Switch to allow cables to pass from the back of the equipment rack to the front panel of equipment (Middle Atlantic BR1 or similar).
10. Equipment with deep front panel connectors or controls (such as Ethernet Switches) that interfere with a front door or pose a potential hazard shall be installed on rack rail recess adapters (Middle Atlantic RR2-3RCN or similar).
11. Where applicable, mount small components behind vent panels on sub-chassis shelves or component panels (BUD CB series chassis or similar). Mount components with connections visible from rear of equipment rack using barrier strip terminal blocks for connections.
12. The following guidelines concerning equipment rack layouts shall be followed. Submit shop drawings illustrating proposed equipment rack layouts, indicating equipment labels.
 - a. Equipment Rack Layouts shall be grouped according to function; audio, video, and control.
 - b. Heavy equipment such as audio amplifiers, large video matrix switches, and UPSs shall be placed near the bottom of equipment racks.
 - c. Control equipment shall be located near the top of equipment racks.
 - d. Equipment that requires operator interface (e.g. sound reinforcement system AC power pushbuttons, sound reinforcement system mode select switches, power amplifier monitor/test system, monitor loudspeaker, computer monitor and keyboard, patch panels, audio mixers, program source and/or audio-visual equipment) shall be installed in one or adjacent equipment racks. Operator interface equipment shall also be installed at heights that permit ease of operation and viewing. Such equipment shall be placed in equipment rack(s) closest to the audio equipment room entrance.

B. Portable Equipment Cases

C. Hardware and Accessories

1. Table Connection Box, number (#) of gangs as required, with sloped face and cable exit at back.
 - a. Ace Backstage 147G# (only up to 3-gangs); or
 - b. Extron SMB 11#; or
 - c. FSR Inc. DSKB-#G; or
 - d. RDL DC-#B.
 - e. Coordinate mounting conditions with existing conditions, millwork, and as determined during commissioning. Where left loose, provide rubber feet for the box.
2. Surface Mounted Wallboxes, standard gang size, used as the backbox for connection plates where standard electrical boxes cannot be flush mounted in wall, steel construction, paintable.
 - a. Extron EWB 10#; or
 - b. FSR Inc. SMWB-#G; or
 - c. RDL SMB-#B.
 - d. Color as selected by Architect.
3. Surface Mounted Raceway, steel construction, paintable, with surface mounted boxes, raceway, and fitting sizes as required.
 - a. Legrand Wiremold; or

- b. Equal.
- 4. Surface Mounted Wireway, plastic construction, with cover, size as shown on the drawings.
 - a. Panduit PANDUCT; or
 - b. Equal.
- 5. Threaded Pipe, cold rolled steel, 1.5 inch NPT size.
 - a. Provide length as required to mount devices as shown on drawings.
- 6. Unistrut, slotted metal framing, steel construction, member sizes and fittings as required.
 - a. All channel members shall be fabricated conforming to one of the following ASTM specifications:
 - 1) Plain Carbon Steel: ASTM 1011 SS Grade 33
 - 2) Pre-Galvanized Carbon Steel: A 653 Grade 33
 - b. All fittings shall be fabricated conforming to one of the following ASTM specifications:
 - c. Carbon Steel: All carbon steel fittings shall be fabricated from steel that meets/exceeds the physical requirements of ASTM A1011 SS Grade 33 and conforms to one of the following ASTM specifications:
 - 1) ASTM 575.
 - 2) ASTM 576.
 - 3) ASTM 36.
 - 4) ASTM 635.
 - 5) ASTM1059.
 - 6) ASTM 1046.
 - d. Finishes
 - 1) Factory painted with rust inhibiting thermoset acrylic enamel paint applied by electro-deposition after cleaning and phosphating, and thoroughly baked.
 - 2) Polyester powder coat after cleaning and phosphating, and thoroughly baked.
 - 3) Electro-galvanized per ASTM B 633 Type III SC 1.
 - 4) Pre-galvanized per ASTM A653.
 - 5) Hot-dipped Galvanized per ASTM A123 or A153.
- 7. Type 1 Barrier Strip, for termination of audio circuits in equipment rack where shown on the drawings and/or needed for transition between cable types.
 - a. TRW-CINCH 140 series; or approved equal.
- 8. Type 2 Barrier Strip, high-density, for termination of loudspeaker circuits where shown on the drawings and/or needed for transition between cable types.
 - a. Phoenix Contact High-Density UK series; or approved equal.
- 9. Spade Tongue Terminal, brazed seam, uninsulated type only.

2.10 AC POWER

- A. Furnish modular vertical power strip in each Floor Standing Equipment Rack with number of circuits and corresponding color-coded always-on and sequenced outlets as required. Each rack shall have at least four spare always-on receptacles. Furnish additional power distribution equipment as required for all equipment racks.
- B. Furnish an Uninterruptible Power Supply for the following equipment.
 - 1. Digital Audio Processors.
 - 2. Digital Mixing Consoles.
 - 3. Video Processors.
 - 4. Ethernet Switches.
 - 5. Control Systems and accessories.

- C. Furnish power conditioning and surge suppression for all major video, audio, and network equipment not served by a UPS. Video Projectors may be excluded; the branch circuits serving this equipment will be conditioned and protected by centralized equipment provided by others.
- D. Label all uninterruptible power supply AC power receptacles with a label which reads "UPS".
- E. Provide sequencing control of AC power for all the audio-visual communication system components (excluding projectors and flat-panel displays) not connected to a UPS from switches located at the equipment rack in the sound booth. Connect the system components to the sequencers such that equipment turns on in the following order:
 - 1. Audio and Video Source Equipment.
 - 2. Audio Mixers, Video Switchers, and other miscellaneous equipment.
 - 3. Digital Signal Processors.
 - 4. Audio Amplifiers.
 - 5. Adjust the sequencing time so that all equipment startup cycles are complete before the next AC power circuit is energized.
 - 6. Power off sequencing shall occur in reverse order.
- F. Connect power amplifiers to 120V 20A AC power circuits so that maximum rated input power can be delivered to each power amplifier without exceeding the power handling capacity of any AC power circuit.
- G. Except for tape machines, video monitors, phono turntables, compact disc players, and other user operated equipment, all equipment AC power switches that are accessible from the front of the equipment racks (and not covered by acrylic plastic covers), shall be wired out of their circuits so that the AC power to each unit cannot be turned off.
- H. Any power distribution details shown on the drawings are for concept only. Shop drawings are required indicating the exact equipment to be furnished by the Systems Contractor.
- I. AC Power Equipment

PART 3 - EXECUTION

3.01 GENERAL

- A. Installation and connection of audio-visual communication system equipment, materials, cable, and cable fittings shall be performed only by experienced audio-visual communication system installers. Each installer shall have access to a complete copy of the specifications at the job site.
- B. All materials and equipment are to be installed in accordance with all applicable standards of the National Electrical Code, the Electrical Code of the governing local municipality, all other applicable local codes, and all safety codes and ordinances.

3.02 INSTALLATION

- A. Equipment rack sheet metal ground shall only be via the insulated ground cable(s) noted on the drawings. Racks shall not otherwise connect to building steel or electrical conduit which is grounded to the building electrical system. Adjacent equipment racks shall be connected by an insulated #6 AWG ground cable which is bonded to each equipment rack.
- B. All adjacent equipment racks shall be ganged together if applicable.
- C. All equipment racks shall be restrained and seismic rated as required by local code.
- D. Racks shall be thoroughly cleaned prior to turn over to the Owner.
- E. Rear rack rails shall be installed as required to support heavy or deep equipment.

- F. Lacing bars shall be installed to assist in organizing cable. Lacing bars shall not interfere with access to any terminations or connectors.
- G. Cable within equipment racks shall be separated and routed in groups according to function: microphone circuits, intercom circuits, line level audio circuits, loudspeaker circuits, video circuits, control circuits, and 120 volt AC power circuits. Cable shall be neatly arranged, but tight bundling which makes modifications difficult shall be avoided. Plastic or Velcro cable ties shall be used for grouping of circuits. Unless otherwise noted on the drawings, all cables shall enter the equipment racks in one of the following manners:
 - 1. Through conduit landed directly to the equipment rack.
 - 2. Through rack knock-outs on the top or back of the equipment rack with plastic or rubber grommets.
 - 3. Directly into the back of wall mounted equipment racks. The rack shall be installed over flush mounted junction boxes allowing all cables to pass directly from the junction box into the back of the rack.
 - 4. Directly into an open side of floor standing equipment racks without side panels.
 - 5. Directly into the bottom of floor standing equipment racks through access floor holes or conduit in the floor. The rack shall be installed above the conduit stub or hole allowing all cables to pass directly into the bottom of the rack. All conduit stubs or access floor holes shall also have a plastic or rubber bushing to protect the cables.
- H. Cable in conduit or other raceway shall be separated according to function: microphone circuits and intercom circuits, line level audio circuits, loudspeaker circuits, video circuits, control circuits, and 120 volt AC power circuits. Control circuits may be installed in line level audio conduit where separate control conduit is not indicated on the drawings. Control circuits for loudspeaker volume control priority override relays may be installed with loudspeaker circuits. Intercom circuits may be installed in line level audio conduit where microphone level conduit is not installed.
- I. Any grouping of cables left exposed in a room, such as those associated with a movable equipment rack, shall be bundled together into a single bunch using black, flexible and expandable sleeving such as Techflex Flexo Wrap or equivalent.
- J. At all connection points for all types of cable, self-laminating or heat shrink printed labels of appropriate letters and/or numbers shall be installed near each termination point and be clearly visible. The labels shall be consistent on both ends of the same cable. These cable numbers and/or letters shall be given to the Acoustical Consultant for inclusion on the one-line diagrams of record.
- K. Care shall be exercised in wiring so as not to damage cables and equipment. Circuits shall not be spliced except as approved on shop drawings.
- L. Where conduit connects between equipment rack locations, or between sound console and equipment racks, at least two spare circuits of each type in the conduit (microphone level, line level, control, or data communications) shall be installed in each conduit used. All spare circuit conductors shall be connected to chassis ground at the downstream (e.g. power amplifier) end of the cable.
- M. All field cabling shall have service loops to allow for at least two (2) re-terminations.
- N. All crimp type connectors, including insulated butt connectors for inline loudspeaker circuit connections, shall be crimped with a Thomas & Betts model WT111M tool. Spade tongue terminals shall be crimped with the notch on the barrel opposite the seam.

- O. Unless otherwise noted, all audio circuits shall be two wire with shield, with the red or white wire used for the "high" side of the line and connected to pin 2 of microphone connectors or to the "tip" of patch panel and other phone jacks. The black wire shall be used for the "low" side of the line and shall connect to pin 3 of microphone connectors or to the "ring" of phone jacks. The shield (drain) wire shall connect to pin 1 of microphone connectors or to the sleeve of phone jacks.
- P. All audio circuits (red or white and black conductors) shall be ungrounded except as provided by single ended amplifier inputs and where grounding of unbalanced circuits is directed during system tests. Shields for line level audio circuits shall be grounded to rack sheet metal at each cable termination. Where line level audio circuits connect to audio transformers, shields shall connect to transformer electrostatic shields and case grounds. At each cable termination shield or shield drain, wire length shall be approximately equal to the length of the insulated conductors. Shield drain wires shall be sheathed in green PVC sleeving. Circuit shields shall not otherwise connect to each other nor ground to electrical conduit at wall boxes, etc. Microphone circuit shields shall be grounded only at mixer inputs.
- Q. Where resistors are indicated to terminate an audio circuit, install each resistor at the end of the line at the input to the following transformer or amplifier.
- R. All wire joints and connections in the audio system shall be made with rosin core solder and a small soldering iron; or with approved mechanical connectors. Soldering shall be neat and shall not exhibit "cold" solder joints. Connections to screw type terminals shall be made with mechanically connected, uninsulated, spade type lugs selected for the particular wire size in use.
- S. Connections made with miniature screw actuated, phoenix type connectors shall be made by stripping approximately ¼-inch of insulation from stranded conductor, inserting the untinned wire into the pressure terminal, and tightening the terminal screw using a small screwdriver which securely fits the screw head.
- T. High impedance unbalanced audio circuits shall not extend more than 20 feet.
- U. Loudspeaker connections within loudspeaker enclosures (and at other in-line locations where necessary) shall be made with crimped insulated butt connectors. Wire nuts and/or electrical tape will not be allowed.
- V. Loudspeakers shall be installed so there are no obstructions to the loudspeaker coverage pattern. Loudspeakers shall be connected "in phase" and proper impedance matching shall be maintained between amplifiers and loudspeakers.
- W. Tie-wrap and secure all loudspeaker line matching transformer leads and loudspeaker cable away from loudspeakers to prevent "rattling" when loudspeakers are energized.
- X. All loudspeakers, projectors, and any other equipment suspended overhead shall be installed by a qualified rigging technician following manufacturer's installation guidelines for all rigging components and as indicated on the approved shop drawings. Any changes made to the rigging design during installation shall be updated on the project record as-built drawings and re-approved by the Systems Contractor's structural engineer.
- Y. All loudspeakers, projectors, and other equipment suspended overhead shall be installed with wire rope safety ties connected to the building structure as shown and approved on the submitted shop drawings.
- Z. All analog video circuits, except as indicated otherwise, shall be shielded 75-ohm coaxial cable. Shields for video circuits shall be grounded only at the connected equipment and shall not ground at electrical conduit at wall boxes, etc.
- AA. All analog video connections shall be made with a specified BNC type connector. The BNC plug center pin shall be crimped with a Trompeter 010-0055 or Buchanan 613439 crimp tool.
- BB. No field terminated digital video connectors will be permitted unless otherwise noted in these specifications or drawings (HDMI, DVI, DisplayPort).

- CC. No soldering of video connectors will be permitted.
- DD. All non-locking video connectors shall be secured to the installed equipment such that the connectors cannot be easily disturbed or disconnected.
- EE. All HDMI, DisplayPort and DVI cables shall not exceed 25 feet in length without the installation of an active HDMI or DVI Cable Equalizer, with the exception of cables terminating or originating at equipment which features integral cable equalization. These cables shall be limited in length as indicated by the equipment manufacturer's recommendations.

3.03 NAMEPLATES AND CONNECTION PLATES

- A. All nameplate nomenclature shall be reviewed by the Architect and Acoustical Consultant prior to panel or plate engraving; or Metal-photo processing.
- B. All control panels, all patch panels, and all controls, jacks, microphone receptacles, switches, etc. (except for controls, etc., on audio equipment which are properly identified by the manufacturer) shall be suitably identified by metal or plastic engraved labels or Metal-photo labels. Engraved panels or plates shall be filled with a suitable contrasting color as approved on shop drawings.
- C. Room numbers shown on drawings and indicated on control panel details, patch panels, etc., are architectural room numbers for identification only during the construction phase. Fabricated labels shall reflect the room numbers to be later assigned by the Owner and/or as designated by the Architect.
- D. All installed and portable equipment shall be identified on front and rear panels by nameplate labels as indicated on the drawings and approved in the shop drawings, or as directed on-site by the Owner, Architect, and/or Acoustical Consultant.
- E. Unless noted otherwise, standard gang connection panels shall be Sierra stainless steel wall plates, or color as selected by Architect.
- F. Unless noted otherwise, NEMA size connection panels shall be clear anodized brushed aluminum, or color as selected by Architect.
 - 1. 12-inches or smaller: 1/8-inch thick.
 - 2. Larger than 12-inches: 3/16-inch thick.
 - 3. Field-verify mounting conditions for each box. Flush mounted plates shall have a minimum 1/2-inch flange on all sides.
- G. All connection panels shall have countersunk screw holes and Phillips countersunk or oval-head screws finished to match the panel. All lettering shall be engraved and filled directly on the panel. Regardless of panel color, all panel mounted connectors should match the finish color of the panel wherever possible.
- H. All standard sized rack panels used to mount controls or connectors shall have formed edges, with all lettering engraved and filled directly on the panel.
- I. Verify all dimensions and spacing for panel-mounted components and engraving. Unless noted otherwise, engraved text shall be 3/16-inch high. Spacing between panel-mounted components shall be sufficient to enable front cable connections to be made easily.
- J. Connection panel layouts shall be according to function with all connections of one type located together. Labels shall be located above the corresponding connector or component. All connection panels and nameplates on the project shall be uniform in layout and nomenclature. Microphone multipin connectors shall be placed at the bottom of connection panels.
- K. No wall or floor mounted connection panels shall carry the logo of the contractor's firm.
- L. All nameplates and patch panel labels shall reflect Alternates accepted or rejected.
- M. Submit shop drawings for each connection panel with all connections, devices, labels, colors and sized clearly indicated.

3.04 PAINTING

- A. Paint all exposed hardware, loudspeakers, baffles, wall plates, and any other item furnished under this contract not specifically noted otherwise on the drawings, color and method as selected and approved by the Architect.
- B. Any custom painting of loudspeakers shall be done at the factory or other controlled environment using spray or powder-coat process without damage to components or blocking grille openings. Except as otherwise noted herein, painting with brush or roller is not acceptable. Verify all finishes with Architect and indicate on shop drawings submitted for review.

3.05 PRELIMINARY SYSTEM TESTS AND ADJUSTMENTS

- A. The Systems Contractor shall be responsible for preliminary field tests and adjustments of the completed audio-visual communication systems prior to the time reserved for system equalization. Circuits containing equalizers and resistors to be installed later may be strapped across to permit preliminary system testing. Such tests shall be made in conformance with the recommendations of the equipment manufacturer and Acoustical Consultant.
- B. Preliminary system tests and adjustments shall include but not be limited to the following
 1. Verification that all loudspeakers are properly installed, tapped, and circuited as indicated on the drawings.
 2. Measurement of each loudspeaker line impedance to verify that no short/open circuits exist (including shorts to conduit/ground) and proper/expected loads are connected.
 3. Testing of each loudspeaker to ascertain that none of the units "squawk" or "rattle" when energized with one-third octave bands of pink noise at a nominal input power of two watts.
 4. Phasing of all microphones, microphone cables, and microphone inputs.
 5. Alignment, convergence and source input settings for each video projector and flat panel display.
 6. Verification that each display meets the following criteria: a minimum resolution compatibility of 1920x1080 @ 60Hz, HDCP compliance where required, appropriate color reproduction, and confirmation that the number of malfunctioning pixels does not exceed the manufacturer's tolerance.
 7. Equalization of any analog video system components will involve setting video amplifiers so the video blanking level is at 1.0 volt peak-to-peak throughout the video system.
 8. Qualification of all Category-type field cabling.
 9. Functional tests of all individual audio and video equipment
 10. Functional tests of all control equipment and custom user interfaces. All control communication shall be verified and tested to perform the functions listed in these specifications and detailed in the custom touchpanel interface.
 11. Setup of all VOIP and Videoconference Systems on the Owner's network.
 12. Setup of all dedicated networks, including assignment of appropriate IP addresses for all equipment, setup of any DHCP servers and wireless access points, and switch configuration.
 13. Unbox, assemble, test, and all store portable equipment where appropriate.
 14. Installation of the latest product firmware and software.
 15. Functional tests of the installed system(s) as required to assure that the system(s) are ready for final tests and adjustments.
- C. The Systems Contractor shall be responsible for notifying the Acoustical Consultant of any unresolved malfunctions encountered during preliminary system tests and of any equipment not at the site sufficiently prior to system equalization.

- D. Most of the final tests and adjustments will be performed concurrently with system equalization. However, if troubles are encountered, preliminary tests and adjustments shall continue until the system operates in a satisfactory manner.

3.06 FINAL SYSTEM TESTS AND EQUALIZATION (COMMISSIONING SERVICES)

A. Sound Systems

1. The process is termed system "tuning" or "equalization" and is accomplished after the completion of the system installation, but prior to any use of the audio-visual communication system. At this time, it is possible to measure the acoustic response of the system and to determine the feedback frequencies that actually exist. The broadband and narrowband filters are then tuned to these specific conditions.
2. To achieve proper acoustic levels and aiming, select loudspeaker transformers may require re-tapping and select loudspeakers or loudspeaker clusters may require reorientation as directed by the Acoustical Consultant.
3. After the sound reinforcement system(s) has received its preliminary testing and is found to be operating correctly, without hum, distortion, oscillations, radio frequency interference, etc., all equipment is fully functioning, and all circuits and connections have been examined, the system shall be commissioned and configured, including, but not limited to, the following adjustments:
 - a. Adjustment of all gain controls to proper levels.
 - b. Equalization of the loudspeaker systems using broadband graphic or parametric equalizers, delays, and compressors/limiters.
 - c. Equalization of each installed wired and wireless microphone using broadband graphic or parametric equalizers and any applicable dynamics.
 - d. Proper setup of any automatic mixer processing.
 - e. Proper setup of all wireless microphone systems, including coordination of all wireless microphone frequencies.
 - f. Configuration of the mixing console with input from the Owner.
 - g. Configuration of narrowband equalizers to minimize microphone feedback in the system.
 - h. Proper setup of any acoustic echo cancellation processing.

B. Audio-Visual Systems

1. After the audio-visual system(s) has received its preliminary testing and is found to be operating correctly, all video displays are fully operational, all equipment is functioning properly, and all circuits and connections have been examined, the system shall be commissioned and configured, including, but not limited to, the following adjustments:
 - a. Configuration of all EDID and HDCP settings for each source and display.
 - b. Proper setup of all video scalars.
 - c. Proper setup of each display for color and brightness.
 - d. Adjustment of camera image settings and configuration of any pan/tilt/zoom presets.
 - e. Configuration of videoconferencing systems with input from the Owner.
 - f. Configuration of recording systems.
 - g. Configuration of streaming video systems.

C. Networking and Control Systems

1. After the networking and control system(s) has received its preliminary testing and is found to be operating correctly, all control interfaces are fully operational, all equipment is functioning properly, and all circuits and connections have been examined, the system shall be commissioned and configured, including, but not limited to, the following adjustments:
 - a. Verification of all specified control operations.

- b. Verification and adjustment of all user control interfaces for proper operation, with input from the Owner for custom interfaces.
 - c. Verification of all control software installations.
 - d. Verification of a proper Ethernet network configuration.
- D. The Systems Contractor shall furnish the services of a competent technician, one having knowledge of the system, to adjust the audio-visual communication system equipment and connections as requested by the Acoustical Consultant during the time reserved for system equalization. It is estimated that this technician should be available for approximately five (5) 11 hour days.
- E. These periods of time will be used for equalization and final system tests and adjustments. They will not, however, include the time that might have to be expended in the correction of system wiring errors, improper system performance due to noise, oscillations, etc. The Systems Contractor shall make his own assessment of the total time required for the technician referenced above.
- F. If, in the opinion of the Acoustical Consultant, the system does not appear to be functioning properly, the Systems Contractor may be required to perform tests on any individual item of equipment to determine its operational status. Any measurements deemed necessary shall be made for frequency response, distortion, etc.
- G. If after maximum effort by all concerned, it should prove impossible to complete the equalization within the stipulated period, the technician shall be made available for additional hours at no additional cost to the Owner if the Acoustical Consultant feels such assistance is necessary.
- H. The commissioning services shall be provided for the Owner by AVANT ACOUSTICS, the Acoustical Consultant. These services shall be the subject of a separate contract directly between the Owner and the Acoustical Consultant.

3.07 SYSTEM WARRANTY AND MAINTENANCE

- A. The Systems Contractor shall warrant the audio-visual communication system against defects in materials and workmanship, including any required parts and labor, during a one year warranty period from date of final acceptance or first beneficial use, whichever occurs first, of the completed audio-visual communication system at no cost to the Owner.
- B. The Systems Contractor shall make at least two visits to the job site to determine that all equipment is functioning satisfactorily, and to perform any maintenance services that may be required. The first of these visits shall occur approximately six months after the commencement of the warranty period, and the second visit shall occur approximately six months thereafter, but prior to the end of the warranty period.
- C. Maintenance services requiring additional visits shall also be performed at no charge. Maintenance services shall consist of, but not be limited to, operational tests and checks of all equipment.
- D. Any defective equipment discovered during any maintenance visit shall be repaired or replaced under the terms of the warranty. The Systems Contractor shall not be liable for equipment damaged by improper use, negligence, or accidental acts of nature.
- E. Warranty and maintenance services shall be restricted to normal working hours unless the Owner agrees to pay the difference in labor rates for overtime work.

3.08 NOTEBOOK OF OPERATING INSTRUCTIONS

- A. The Systems Contractor shall assemble electronic notebooks (a collection of digital files) for each audio-visual communication system listed and as described below, and forward accurate field drawings of all wire numbers and control panel and patch panel engraving (for use in record drawing revisions) together with the electronic notebooks to the Acoustical Consultant for review.
 - 1. Broadcast Studio

- B. The Acoustical Consultant will insert simplified operating instructions, warranty information, and one-line diagrams of record for the audio-visual communication system into the electronic notebooks. The Acoustical Consultant will then forward the electronic notebooks to the Owner through the Architect.
- C. The information described below shall be neatly organized, named appropriately, and placed in a separate folder structure named by room/system type listed above and as follows:

BROADCAST STUDIO
OPERATING INSTRUCTIONS AND MANUALS
WYOMING CAPITOL BUILDING
CHEYENNE, WY

- D. Digital notebook contents shall include the following sections, each noted in the table of contents:
 - 1. Table of Contents, with main entries for each major section and equipment category, and sub-entries for each equipment manual included.
 - 2. System Operating Instructions, to be provided by the Acoustical Consultant.
 - 3. System Warranty information, to be provided by the Acoustical Consultant.
 - 4. One-line Diagrams of Record, to be provided by the Acoustical Consultant.
 - 5. Shop/As-Built Drawings.
 - 6. Parts List, a complete list of all equipment provided on the project, updated for any changes in the field.
 - 7. Equipment Manuals, including manufacturer's warranty information, manufacturers' operating instructions, manufacturers' service manuals having schematic diagrams and parts lists, and any other information pertaining to the operation and routine maintenance of each major item of electronic equipment. This documentation shall be organized and divided into the equipment type categories used in this specification (i.e. Microphones, Microphone Accessories, etc.); either as separate PDF files or as a single file with PDF bookmarks.
 - 8. Equipment software and configuration files, control system code and configuration files, and any software licenses.
 - 9. Video archive of the training session(s), described below.
 - 10. Any other documentation deemed pertinent to the operation and maintenance of the sound reinforcement system.
- E. The electronic version of all the notebook contents shall be provided on a USB drive. All software files shall be included on each USB drive.
- F. If additional project closeout document requirements are listed elsewhere in the project manual, those requirements shall also be followed in addition to these closeout document requirements.

3.09 SYSTEM OPERATING ASSISTANCE

- A. After the audio-visual communication system has received its final testing and equalization and is fully operational, the Systems Contractor and Acoustical Consultant shall instruct designated representatives of the Owner in the proper methods of system operation.
 - 1. The Acoustical Consultant, as part of the System Commissioning agreement, will perform one (1) complete end user training on the systems as a whole.
 - 2. The Systems Contractor shall provide a manufacturer authorized instructor for one (1) advanced training session on the Digital Mixing Console.
- B. The Systems Contractor shall provide video recording for at least one session of each of the system overview and mixing console training sessions described above for inclusion in the Notebook of Operating Instructions.

1. Each recording shall include an introduction that identifies the system, location and equipment being demonstrated. Recordings shall be made with a high-quality camera and microphone, using a tripod where possible, and with proper lighting. Provide additional portable lighting if ambient light is insufficient for recording.
 2. Recordings shall be provided in the MP4 file format, with a minimum 720P resolution, as part of the electronic notebook described above.
- C. The Systems Contractor shall provide system operating assistance for the first two major uses of the completed audio-visual communication system. This assistance shall be provided at the times required by the Owner and there shall be no extra charge for work during this time prior to or after the normal working day.

PART 4 - equipment schedules

4.01 SPARE EQUIPMENT (TO BE TURNED OVER TO THE OWNER)

- A. One (1) Fuse Kit, 125 VAC, including five of each type found on equipment furnished under this contract. Fuses shall be Bussman or equivalent brand. Provide an index in the Operating Instructions/Maintenance Manuals listing appropriate fuse type and size furnished for each item of equipment.

4.02 STANDBY EQUIPMENT

- A. The Systems Contractor shall have the following standby equipment on hand at the job site during the period set aside for system equalizing for the possible replacement of defective components. All unused standby equipment and any replaced equipment shall remain the property of the Systems Contractor
1. XXXX
 2. XXXX

4.03 BASE BID PORTABLE EQUIPMENT QUANTITY

- A. Quantities shown below are only for portable equipment not permanently mounted and/or not permanently connected to the audio-visual communication system. Refer to the drawings for other equipment quantities, or as noted, for additional requirements. Systems Contractor shall unbox, assemble, test, and store portable equipment where appropriate.
- B. Provide Cable straps for all portable cables.
- C. Microphones
- D. Microphone Accessories
- E. Audio Program Source Equipment
- F. Audio Mixers
- G. Portable Loudspeakers
- H. Production Intercommunication System
- I. Audio Accessories
- J. Audio-Visual Accessories
- K. Touchpanels and Remotes
- L. Portable Equipment Cases
- M. Miscellaneous
1. XXX copies of a Notebook of Operating Instructions.

2. XXX sets of Equipment Rack Keys.
3. XXX sets of Equipment Storage Cabinet Keys.

END OF SECTION 274116

SECTION 28 4600
FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 26 Section "Common Work Results for Electrical," for materials and methods for coordination, sleeves and common installation requirements.

1.02 DESCRIPTION OF WORK

- A. This Section requires the Contractor to furnish all materials required to install the fire alarm system. The Contractor shall be responsible for installing, testing, and start-up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities.
- B. Division 28 of the Specifications and Drawings numbered with prefixes FP generally describe these systems, but the scope of the Fire Alarm work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically and are intended to convey the scope of work, indicating the general location and arrangement of the major equipment, devices, appliances, etc. without showing all the exact details as to elevations, circuits, routing, and other installation requirements. Use the Drawings as a guide when laying out the system and verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. The scope of work in this section includes:
 - 1. System smoke detectors
 - 2. Heat detectors
 - 3. Carbon monoxide detectors
 - 4. Notification appliances
 - 5. Air handling unit shutdown

1.03 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality,

size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

- D. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 2 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

1.04 APPLICABLE CODES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities. Upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.
 - 1. NFPA 70, "National Electrical Code", Most Recent Edition.
 - 2. NFPA 72, "National Fire Alarm and Signaling Code", Most Recent Edition.
 - 3. NFPA 101, "Life Safety Code", Most Recent Edition.
 - 4. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
 - 5. FM Global, "Approval Guide", Latest Edition.
 - 6. International Building Code (IBC) Most Recent Edition with local amendments.
 - 7. International Fire Code (IFC) Most Recent Edition with local amendments.
 - 8. ASME A17.1, "Safety Code for Elevators and Escalators", Current Edition.
- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

1.05 DEFINITIONS

- A. General:
 - 1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
 - 2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
 - 3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
 - 4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
 - 5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the AHJ over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
 8. FACP: Fire Alarm Control Panel.
 9. NICET: National Institute for Certification in Engineering Technologies.
 10. VESDA: Very Early Smoke-Detection Apparatus.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.06 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make do provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.
- C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Fire Alarm systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.
- E. Where coordination and interfacing with other systems or equipment is required, it shall be the responsibility of the fire alarm system installer (contractor) to either provide the relays, contacts, power supplies and other necessary hardware or see to it that such hardware is provided with the other systems or equipment.
- F. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:
 1. Sprinkler waterflow and valve tamper switches shall be provided by the fire sprinkler installer, but wired and connected by the fire alarm installer.
 2. Duct smoke detectors shall be furnished, wired and connected by the fire alarm system installer. The HVAC installer shall furnish necessary duct opening to install the duct smoke detector's housing.
 3. Air handling fan control circuits and contacts to be furnished by the HVAC control equipment.
 4. Conduit shall be by Division 26 "Common Work Results for Electrical".
- G. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.07 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.08 SUBMITTALS

- A. Refer to Division 1 and General Conditions for submittal requirements, in addition to requirements specified herein. Submittals not complying fully with the submittal requirements will be rejected.
- B. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval.
- C. Shop drawings shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations. Drawings that are not legible, or that do not contain sufficient detail to verify compliance with applicable codes and standards, will be rejected without further review.
- D. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall it contain the HEI's engineers' seal and signature. They shall not be copies of HEI's work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.
- E. Submit Shop Drawings as early as required to support the project schedule. Allow for two weeks Engineer review time plus mailing time plus a duplication of this time for resubmittal if required. Submit Shop Drawings as soon as possible before construction starts.
- F. Before submitting Shop Drawings and material lists, the Contractor shall verify that the equipment submitted is mutually compatible and suitable for the intended use. Contractor shall verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- G. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- H. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless the Contractor has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.
- I. Product Data: Provide a bill of materials and product cutsheets showing material specifications, electrical characteristics and connection requirements. Highlight or indicate specific product options and accessories as applicable to the project.

J. Shop Drawings:

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Shop drawings shall be prepared by a NICET Level 3 or higher certified technician. Submit copies of the certification for the designer with submittal.
3. The fire alarm system equipment vendor shall provide shop drawings showing fire alarm floor plans and a full building riser diagram. Fire alarm floor plans and riser diagram shall show fire alarm control panel, annunciator, all fire alarm initiating devices and notification appliances. Show typical wiring diagrams of control panel/s, annunciator and each device and wiring connections required. Show all interfaces to other systems, such as temperature control systems, and security systems.
4. The fire alarm floor plans and riser diagram shall show wiring to all fire alarm devices/appliances, indicating wire sizes and quantities as well as conduit/raceway sizes and locations of end-of-line (EOL) resistors. The fire alarm floor plans and riser diagram shall clearly show the routing of all fire alarm system wiring, including all horizontal routing and vertical routing (in chases).
5. Routing of all fire alarm wiring shall comply with the "Survivability" requirements of NFPA 72.
6. Provide a Sequence of Operations Matrix that explains how the submitted fire alarm system functions.
7. Include voltage drop calculations for notification-appliance circuits.
8. Include battery-size calculations.
9. Shop drawing scale shall match the Engineer's drawings where possible. Scale shall not be less than $3/32" = 1'-0"$.
10. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.

K. Indicate within the submittal all applicable UL listings and all applicable approvals or certifications.

L. Qualification Data: Submit copies of the certification for the Installer.

M. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

1.09 ELECTRONIC DRAWING FILES

- A. In preparation of shop or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall complete and send the form attached at the end of this section along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for Substitutions.
- B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and other information necessary for an evaluation. A statement setting forth changes in other materials, equipment or other Work that incorporation of the substitute

Commented [JK1]: As a general rule, it was decided that we do not need to enforce the \$200 fee requirement. We have intentionally left this in the spec for two reasons. 1. Without this, it appears as though we owe the contractors these files as long as they ask, which is not the case. 2. We need to keep the onus of obtaining these files on the contractor. Without the fee, it could be seen that any hesitation to send the files puts us at risk of holding up a contractor's schedule. If we are doing them a favor by sending them at all, their responsibilities remain more clearly in their court.

would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Engineer's decision of approval or disapproval to bid of a proposed substitution shall be final.

- D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
- E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1 and General Conditions for Operational and Maintenance Manuals.
- B. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- C. The O&M Manuals shall be provided in labeled 3-ring binder with cover, binding label, tabbed fly sheets and plastic insert folders for Record Drawings. Include the following sections with the appropriate information for each section:
 - 1. Typewritten Index.
 - 2. Qualifications. Provide designer and installer qualification.
 - 3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
 - 4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
 - 5. Product Data: Provide product cutsheets for all equipment utilized and installed.
 - 6. Riser diagram.
 - 7. Device addresses.
 - 8. Record copy of site-specific software.
 - 9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - a. Equipment tested.
 - b. Frequency of testing of installed components.
 - c. Frequency of inspection of installed components.
 - d. Requirements and recommendations related to results of maintenance.
 - e. Manufacturer's user training manuals.
 - 10. Manufacturer's required maintenance related to system warranty requirements.
 - 11. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.
 - 12. Guarantee. Copy of all guarantees and warranties issued.
 - 13. Contact list with minimum three service representative phone numbers.

1.12 RECORD DRAWINGS

- A. A set of prints shall be kept on the jobsite during construction for the purpose of noting changes to location of all fire alarm equipment, devices, appliances and circuits as finally installed. During the course of construction, the Contractor shall indicate on these drawings, changes made from the Contract Drawings. Particular attention shall be made to those items which need to be located for servicing.

- B. The record drawings shall show actual locations of initiating devices, notification appliances, and end-of-line devices. Show the approximate location, size and type of all wiring and routing of wiring. Drawings should also include one-line riser diagrams showing all devices.
- C. The Contractor shall sign-off on the Record Drawings as being an accurate representation of the completed installation.
- D. Refer to Division 1 and General Conditions for Record Drawings
- E. At the completion of the project, the Contractor shall obtain at their expense, reproducible copies of the drawings and incorporate changes noted on the jobsite work prints onto these sheets. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", with date. The drawings and associated system calculations shall be delivered to the Architect/Engineer.

1.13 SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide 10% of the total or a minimum of one (1) manual pull station.
 - 2. Provide 10% of the total or a minimum of two (2) of each type of automatic smoke detector.
 - 3. Provide 5% of the total or a minimum of one (1) of each type of automatic heat detector.
 - 4. Provide 5% of the total or a minimum of two (2) of each strobe type and candela rating.
 - 5. Provide 5% of the total or a minimum of two (2) of each horn/speaker type. Combination horn/speaker/strobe units matching the units installed are acceptable.
 - 6. Keys and Tools: One extra set for access to locked or tamper proofed components.

1.14 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products indicated in this section with minimum three years documented experience.
- B. Installer: Company specializing in installing the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed Contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire alarm submittal proof of factory training for each installer.
- C. Final checkout and verification: Shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET) registered as level 2 or higher in the fire protection technology certification program. Provide certification information with fire alarm submittal.
- D. The equipment manufacturer's service department shall be fully stocked in standard parts and components and engaged in the maintenance of fire alarm systems. On-the-premises service shall be available within 4 hours of notification, 7 days a week, 24 hours a day.

1.15 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties.
- B. Furnish service and maintenance of fire alarm system including wiring and raceways for one year from date of substantial completion.
- C. All components, system software, parts and assemblies shall be guaranteed against defects in materials and workmanship for the one-year period stated above, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty.
- D. Labor (including travel expenses) to trouble-shoot, repair, reprogram, or replace components shall be furnished by this contractor at no charge during the warranty period.
- E. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software.

1.16 PROJECT CONDITIONS

- A. Conditions Affecting Work In Existing Buildings: The following project conditions apply:
1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting a bid to determine the nature and extent of work involved.
 2. Work in the existing building shall be scheduled with the Owner.
 3. Certain demolition work must be performed prior to the remodeling. The Fire Alarm Contractor shall perform the demolition which involves fire alarm system equipment and materials.
 4. Fire Alarm Contractor shall remove articles which are not required for the new work. Unless otherwise indicated, each item removed by the Contractor during this demolition shall be removed from the premises and disposed of in accordance with applicable federal, state and local regulations.
 5. Fire Alarm Contractor shall relocate and reconnect fire alarm equipment that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. General Contractor shall install finish material.
 6. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
 7. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 8. Locate, identify, and protect Fire alarm services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
- B. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- C. Interruption of Existing Fire alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire watch service according to local Fire Department requirements:
1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of fire alarm service.
 2. Do not proceed with interruption of fire alarm service without Construction Manager's written permission.
- D. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.17 SEQUENCING AND SCHEDULING

- A. Existing Fire alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire alarm system, remove all unused fire alarm equipment, wiring and installation materials not necessary for system functionality or spare parts.

PART 2 - PRODUCTS AND MATERIALS

2.01 SYSTEM DESCRIPTION

- A. Noncoded, UL-listed addressable system, with multiplexed signal transmission and voice/strobe evacuation.

- B. All components provided shall be listed for use with the selected system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Source Limitations for Fire alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested, and will operate, as a system.

2.02 MANUFACTURER

- A. Subject to compliance with requirements, provide products manufactured by the following manufacturers as indicated on the Drawings:
 - 1. Notifier
 - 2. SimplexGrinnell
 - 3. Siemens-Cerberus Division
 - 4. Kidde/Edwards
 - 5. Gamewell-FCI
 - 6. Fike
 - 7. Silent Knight
 - 8. Approved Equal
 - a. Approved equals will not be considered unless formally submitted during the bidding process as an RFI.

2.03 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire alarm signal initiation shall be by one or more of the following devices:
 - 1. Heat detectors.
 - 2. Smoke detectors.
 - 3. Carbon monoxide detectors.
 - 4. Automatic sprinkler system water flow.
- B. Fire alarm signal shall initiate the following actions:
 - 1. Identify alarm and specific initiating device at fire alarm control unit and remote annunciators (if provided).
 - a. A pulsing alarm tone shall occur within the control panel until acknowledged.
 - b. The alarm LED shall flash on the control panel and remote annunciator panel until the alarm has been acknowledged at the control panel/remote annunciator panel. Once acknowledged, this same LED shall latch on and the custom label for the address in alarm shall be displayed on the alphanumeric LCD readout. A subsequent alarm received from another address after acknowledged shall flash the alarm LED on the control panel showing the new alarm information.
 - 2. Transmit an alarm signal to the alarm supervising station.
 - 3. The audible and visible alarm signal shall operate until it is manually silenced or acknowledged.
 - 4. Record events in the system memory.
 - 5. Unlock electric door locks in designated egress paths.
 - 6. Release fire and smoke doors held open by magnetic door holders.
 - 7. Activate voice/alarm communication system.
 - 8. All fan-powered air-handling equipment shall shutdown and remain down until the fire alarm control panel is reset.

9. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 10. Activate preaction system.
 11. Activate smoke-control system (smoke management).
 12. Activate stairwell and elevator-shaft pressurization systems.
 13. Activate emergency lighting control.
 14. Indicate device in alarm on the graphic annunciator.
 15. Shutdown audio system.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
 2. Duct-smoke detectors
 3. High- or low-air-pressure switch of a dry-pipe or pre-action sprinkler system.
 4. Alert and Action signals of air-sampling detector system.
 5. Fire pump running.
 6. Fire pump loss of power.
 7. Fire pump power phase reversal.
 8. Independent fire detection and suppression systems.
 9. User disabling of zones or individual devices.
 10. Loss of communication with any panel on the network.
- D. System Supervisory Signal Actions:
1. Identify specific device causing supervisory signal fire alarm control unit and remote annunciators (if provided).
 - a. Visible and audible supervisory alarm indicated by address at fire alarm control panel.
 - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible supervisory alarm; visible alarm is displayed until device is returned to its normal position/supervisory condition is cleared.
 2. Record events in the system memory.
 3. After a timed delay of 90 seconds transmit a supervisory signal to the alarm supervising station.
 4. Transmit system status to building management system.
 5. Display system status on graphic annunciator.
 6. Duct-mounted smoke detectors shall shutdown their respective unit upon detection of smoke and remain down until manually reset.
 7. Individual fan-powered air distribution equipment less than 2,000 cfm that is not provided with duct detection shall shutdown when the respective air handling unit is shutdown.
- E. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 4. Loss of primary power at fire alarm control unit.
 5. Ground or a single break in internal circuits of fire alarm control unit.
 6. Abnormal ac voltage at fire alarm control unit.

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7. Break in standby battery circuitry.
 8. Failure of battery charging.
 9. Abnormal position of any switch at fire alarm control unit or annunciator.
 10. Voice signal amplifier failure.
- F. System Trouble Signal Actions:
1. Identify specific device causing trouble signal fire alarm control unit and remote annunciators (if provided).
 - a. Visible and audible trouble alarm indicated by address at fire alarm control panel.
 - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible trouble alarm; visible alarm is displayed until device is returned to its normal position/trouble condition is cleared.
 2. Record events in the system memory.
 3. After a time delay of 90 seconds, transmit a trouble signal to the alarm supervising station.
 4. Transmit system status to building management system.
 5. Display system status on graphic annunciator.

2.04 INITIATING DEVICES

- A. Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double action mechanism requiring two actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control unit.
 2. Station Reset: Key or wrench operated switch.
 3. Indoor Protective Shield: Factory fabricated; clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
- B. System Smoke Detectors: Photoelectric type complying with UL 268 operating at 24-V dc, nominal with integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.
1. Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
 2. Device shall have an integral visual-indicating light, LED type, indicating detector has operated and power-on status.
 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 4. Photoelectric detectors shall have sensitivity between 0.5 and 3.5 percent/foot smoke obscuration.
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer's standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.
1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
 2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.

3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.
 5. Provide remote alarm LEDs and remote test stations as shown on the plans.
 6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
- D. Projected Beam Smoke Detectors: Projected Beam Light Source and Receiver designed to accommodate small angular movements and continue to operate without causing nuisance alarms. The detector shall contain an automatic self-calibration circuit to compensate for the accumulation of dust and aging. The detector shall be capable of differentiating between smoke and a beam blockage, and shall be equipped with an internal tamper switch to produce a trouble alarm in the event of tampering with the device.
1. Provide remote alarm LEDs and remote test stations as shown on the plans.
- E. Carbon Monoxide Detectors: Detector complying with UL 2075 and listed for connection to fire alarm system. Detector shall include alarm contacts and trouble contacts. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults. Locate, mount, and wire according to manufacturer's written instructions. Testable by introducing test carbon monoxide into the sensing cell. Test button simulates an alarm condition.
- F. Nonsystem (Single Station) Smoke Detectors: Nonsystem smoke detectors shall be listed as compatible with the fire alarm equipment installed or shall have a contact closure interface listed for the connected load. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.
1. Comply with UL 217; suitable for residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping sound device.
 2. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
 3. Visible Notification Appliance: 177 cd strobe.
 4. Test Switch: Push to test; simulates smoke at rated obscuration.
 5. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
 6. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 7. Integral Visual Indicating Light: LED type, indicating detector has operated and power-on status.
- G. Heat Detectors – Comply with UL 521. Detector shall have twist lock base interchangeable with smoke detectors bases and be equipped with an integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.
1. Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 2. Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 deg F (88 deg C).

2.05 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
1. Combination Devices: Factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system

connections. Minimum audible level and strobe intensity shall meet all requirements for separate appliances.

2. Provide strobe synchronization as required per NFPA 72.
 3. Wall mounted notification appliances shall be manufacturer standard finish (match existing).
 4. Ceiling mounted notification appliances shall be manufacturer standard finish (match existing).
- B. Exterior Alarm Bells: Electric vibrating, 10-inch bell with operating mechanism behind dome and weatherproof bell kit. Sound Rating: 90 dB at 10 feet.
- C. Alarm Speakers: Comply with UL 1480. High quality tone and voice reproduction; capacitor connected for connection to supervised notification appliance circuit; semi-flush mounting; four inch cone; high impact, flame retardant PC/ABS thermoplastic; 25 or 70 VRMS; multi-tapped output power rated ¼ to 2 watts and produce 79 to 88 dB at 10 feet.
- D. Visible Alarm Notification Appliances (Strobes): Xenon strobe lights complying with UL 1971, unfiltered or clear filtered white light, with candela ratings as indicated on drawings. Strobes shall meet all requirements of the Americans with Disabilities Act.

2.06 AUXILIARY DEVICES

- A. Magnetic Door Holders: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24-V ac or dc.
 4. Rating: 120-V ac.
- B. Waterflow Alarm Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer. Switch shall have an adjustable delay to minimize false alarms due to fluctuations in water pressure.
- C. Valve (Tamper) Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer.
- D. Monitor Module: Addressable microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts. Include address setting means on the module.
- E. Control/Relay Module: Provide intelligent control relay modules. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

2.07 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for smoke detectors, notification appliances, or other device requiring protection as indicated on the plans.
1. Factory fabricated and furnished by device manufacturer.
 2. Finish: Factory finished to match the color of the protected appliance or device.

2.08 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Building wire as specified in Division 26.
- B. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.
- C. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's

requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.

- D. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.
- E. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.
- F. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
- G. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- H. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket and red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated.
- I. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits: Provide circuitry, which meets the performance requirements during abnormal conditions, based upon the class of the circuitry selected.
 - 1. Initiating Device Circuits: Match existing circuits.
 - 2. Notification Appliance Circuits: Match existing circuits.
 - 3. Signaling Line Circuits: Match existing circuits.
 - 4. Any circuits interconnecting fire alarm control panels between separate buildings shall be provided with surge protection.

2.09 ACCESS TO EQUIPMENT

- A. All detectors, modules, equipment, etc. shall be located so as to provide easy access for operation, service inspection and maintenance.
- B. Access Doors:
 - 1. Provide access doors for all concealed equipment, except where above lay-in ceilings.
 - 2. Access doors shall be adequately sized for the devices served with a minimum size of 18" x 18", furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
 - 3. Access doors must be of the proper materials for type of construction where installed.
 - 4. The exact location of all access doors shall be verified with the Architect prior to installation.
 - 5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 - 6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - 7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
 - 8. Locking Devices: Flush, screwdriver-operated cam locks.

9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.
10. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Arrow United Industries.
 - b. Bar-Co., Inc.
 - c. J.L Industries.
 - d. Karp Associates, Inc.
 - e. Milcor Div. Inryco, Inc.
 - f. Nystrom Building Products
 - g. Wade
 - h. Zurn

PART 3 - EXECUTION

3.01 GENERAL

- A. The Contractor shall install, program and test all new equipment identified in this contract in accordance with the applicable codes, standards, and manufacturer's instructions.
- B. The installation supervisor shall be on the job site during the entire installation. The installation supervisor shall maintain marked up copies of the drawings at the job site showing as-built conditions. These drawings shall be updated daily and available for Owner review.
- C. The Contractor shall provide all required conduit and all associated hardware, and shall install (pull), connect, and test all cable for a complete fire alarm system. All wiring shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

3.02 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.
 1. Connect new equipment to existing control panel.

2. Expand, modify, and supplement existing control/monitoring equipment as necessary to extend existing functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
- D. Manual Fire alarm Boxes: Provide manual fire alarm boxes as shown on drawings. Mount manual fire alarm box on a background of a contrasting color. The operable part of manual fire alarm box shall be at 48 inches above floor level unless noted otherwise.
- E. Smoke and Heat Detectors: Provide detectors as shown on drawings.
 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.
 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat detector spacing.
 3. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 4. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
 5. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
 6. Install ceiling mounted detectors in areas with exposed structure tight to underside of floor/roof deck unless noted otherwise on drawings.
- F. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.
 1. Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.
 2. Provide duct detection and shutdown for fan powered air distribution equipment exceeding 2,000 cfm.
 3. Provide equipment and connections to shutdown fan powered air distribution equipment with a capacity less than 2,000 cfm that are part of an air distribution system with a capacity greater than 2,000 cfm.
- G. Carbon Monoxide Detections: Provide detectors as shown on drawings. The installation shall comply with manufacturer's recommendations and NFPA 720, "Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment," as referenced by NFPA 72.
- H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in unsprinklered elevator shafts.
- I. Single Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, or valve-tamper switch that is not readily visible from normal viewing position.
- K. Install ceiling mounted visible and audible/visible notification appliances in areas with exposed structure to bottom of floor/roof structure or at 30 ft AFF, whichever is lower.
- L. Install ceiling mounted visible and audible/visible notification appliances in areas with finished ceilings flush with bottom of ceiling or at 30 ft AFF, whichever is lower.
- M. Install wall mounted visible and audible/visible notification appliances with visible element (strobe) between 80 inches and 96 inches above finished floor unless noted otherwise on drawings.

- N. Install wall mounted audible devices with the top of the device at least 90 inches above finished floor or 6 inches below the ceiling, whichever is lower, unless noted otherwise on Drawings. If combination devices are installed, they shall be installed per the visible signal device requirements.
- O. All notification appliance speakers shall be tapped at ½ watt unless noted otherwise on drawings. In rooms less than 100 sq ft, speakers are permitted to be tapped at ¼ watt.
- P. Mount outlet box for electric door holder to withstand 80 pounds (36.4 kg) pulling force.

3.04 PATHWAYS

- A. Pathways above suspended ceilings and in nonaccessible locations may be routed exposed where permitted by NFPA 70 & 72.
 - 1. Exposed pathways located less than 96 inches above the floor shall be installed in conduit.
- B. Pathways shall be installed in conduit.
- C. All detection and control circuits associated with smoke control systems shall be fully enclosed within continuous raceways.
- D. Minimum allowable conduit size shall be ¾ inch. The conduit shall be sized so that conduit fill does not exceed 75% of NFPA 70 maximum fill requirements. Cables in vertical risers shall not exceed 50% of NFPA 70 maximum fill requirements. Conduit installation shall be as required by the Contractor's layout and as described in these specifications. All conduit field routing shall be acceptable to the Owner. Routing not acceptable shall be rerouted and replaced without expense to the Owner.
- E. All wire, cable, conduit and raceways shall be concealed in walls, ceiling spaces, electrical shafts or closets in finished areas except as specifically noted otherwise. Conduit and raceways may be exposed in unfinished areas or where specifically approved by the Owner.
- F. Except as otherwise specified or indicated on the drawings, all conduit shall be installed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
- G. Conduit shall be located at least six inches from hot water or steam pipes, and from other hot surfaces. Conduit shall not block access to any existing equipment or fixtures.
- H. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit for conventional hardwired class B initiating and notification appliance circuits.
- I. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. Conduit shall enter cabinets from the bottom and sides only.

3.05 CONNECTIONS

- A. All wiring shall be terminated at devices or panels using terminal connectors for screw type terminals. All terminal connectors for conductors shall be pre-insulated ring type or pre-insulated spade type. Pre-insulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Pre-insulated terminal connectors shall include a metallic support sleeve bonded to the vinyl-insulating sleeve and designed to grip the conductor insulation.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Alarm initiating connection to smoke control system (smoke management) at firefighters' smoke control system panel.
 - 2. Alarm initiating connection to stairwell and/or elevator shaft pressurization systems.
 - 3. Smoke dampers in air ducts of designated HVAC systems.

4. Provide equipment and connections to shutdown fan powered air distribution equipment with an individual capacity less than or equal to 2,000 cfm that are part of an air distribution system with a design capacity greater than 2,000 cfm.
5. Magnetically held-open doors.
6. Electronically locked doors and access gates.
7. Alarm initiating connection to elevator recall system and components.
8. Alarm initiating connection to activate emergency lighting control.
9. Connection to disable sound systems upon alarm activation.
10. Supervisory connections at valve supervisory switches.
11. Supervisory connections at low-air pressure switch of each dry-pipe sprinkler system.
12. Supervisory connections at elevator shunt-trip breaker.
13. Data communication circuits for connection to building management system.
14. Supervisory connections at fire pump power failure including a dead-phase or phase-reversal condition.
15. Supervisory connections at fire pump engine control panel.

3.06 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.07 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. All conduits and junction boxes shall be labeled as specified in Division 26 (red).
- C. The location of end-of-line resistors shall be identified with a label indicating "EOL."
- D. Provide label at each initiating device indicating the device address. Label shall be visible from the floor below or immediately adjacent to the device.

3.08 GROUNDING

- A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.09 FIELD QUALITY CONTROL

- A. Systems shall be checked and tested in accordance with the instructions provided by the manufacturer to insure that the system functions as required and is free of grounds, opens, and shorts. Each device shall be tested.
 1. Smoke detectors shall be tested with products of combustion.
- B. Upon completion of the system installation and before the Date of Final Acceptance, a factory-trained technician shall perform all necessary tests and adjustments and shall then file a Letter of Certification and a Certificate of Completion (NFPA 72) with the Owner indicating that the system functions and conforms to the Fire Alarm System Specifications.
- C. Upon completion of the system installation, a factory-trained technician shall perform all necessary tests and adjustments in the presence of the Owner's designated personnel. Test in accordance with NFPA 72 and requirements of the authority having jurisdiction. Perform the following tests at a minimum:
 1. Visual Inspection: Conduct visual inspection prior to testing. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion

Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - a. Test audible appliances for the public operating mode according to manufacturer's written instructions.
 - b. Test visible appliances for the public operating mode according to manufacturer's written instructions.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire alarm system will be considered defective if it does not pass tests and inspections.
- F. Include services of factory trained and certified technician to supervise installation, adjustments, final connections, and system testing as performed by the fire alarm contractor's factory-trained technicians.

3.10 DEMONSTRATION

- A. The equipment supplier's factory trained technician shall train the Owner's personnel in the proper use and maintenance of the system. Training sessions shall be conducted as needed, not to exceed a total of 2 sessions, with each session lasting a maximum of 4 hours each.
- B. Demonstrate normal and abnormal modes of operation, and required responses to each.
- C. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

END OF SECTION 28 4600

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