PROJECT MANUAL

PROJECT:

DEXTER HIGH SCHOOL – NEW FIELD HOUSE
2200 North Parker Road
Dexter MI 48130

OWNER:

DEXTER COMMUNITY SCHOOL DISTRICT
2704 Baker Road
Dexter, MI 48130

TMP PROJECT NO.: 25026E

DESIGN RELEASE 2

DATE: February 26, 2026

ISSUED FOR: CONSTRUCTION DOCUMENTS

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Dexter High School – New Field House

TMP 25026E

This Document has been prepared under the supervision of the Architect and/or Professional Engineer as indicated by their individual License Seals affixed hereon.

Professional License Seals

Seal	Seal	Seal
TMP Architecture, Inc. *Architect*	***William A. Kibbe Associates*** *Structural Engineer*	***Peter Basso Associates, Inc*** *Mechanical Engineer*

Seal	Seal
Peter Basso Associates, Inc *Electrical Engineer*	***Beckett & Raeder INC*** *Civil Engineer*

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APPENDIX 1

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END OF SECTION

SECTION 00 0115 - LIST OF DRAWINGS

LIST OF DRAWINGS

1.01 GENERAL

A. Drawings: Drawings consist of the Contract Drawings including drawings listed on the TITLE SHEET page of the separately bound drawing set titled New Dexter Field House, dated February 26, 2026 and any subsequent Addenda and Contract modifications which may occur.

END OF SECTION 00 0115

SECTION 00 3100 - AVAILABLE PROJECT INFORMATION

PART 1 GENERAL

1.01 SUMMARY

A. Project Manual uses Appendixes to organize information that does not conform to 3-part specification formatting as defined by the Construction Specifications Institute (CSI).

1. Appendix information does not have a six-digit number or title as defined by CSI's MasterFormat.

1.02 EXISTING CONDITIONS

A. Certain information relating to existing surface and subsurface conditions and structures is available to bidders as Information Available to Bidders, but will not be part of Contract Documents, as follows:

1. Geotechnical Report: Entitled Report of Geotechnical Investigation - 2025 Dexter Schools Bond Program - DHS Fieldhouse and Site Improvements and Al Ritt Stadium Lighting, dated December 29, 2025.
   a. Copy is attached to Project Manual in Appendix 1.

1.03 MISCELLANEOUS INFORMATION

A. Miscellaneous information relating to the project is available in the Appendixes as follows:

1. Includes information issued as an Appendix by Addendum or other subsequent Contract modification.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION -- NOT USED

END OF SECTION 00 3100

SECTION 00 8200.01 - TMP ELECTRONIC FILE RELEASE FORM

.

RE: AUTHORIZATION FORM FOR CAD FILE TRANSFERS
PROJECT NAME: _____
TMP PROJECT NO. : _____ BID PACK NO._____

DEAR SIR/MADAM:

A. Per your request, TMP Architecture, Inc. will electronically transmit requested CAD files upon receipt of an original signed copy of this form which states the conditions of agreement and the receipt of the required compensation fee.
B. By acceptance it is understood and agreed that the data and medium being supplied is to be used only for the project referenced.
C. It is further understood and agreed that the undersigned will hold TMP Architecture, Inc. and its Consultants harmless and indemnify TMP Architecture, Inc. and its Consultants from all claims, liabilities, losses, and so forth, including attorney's fees arising out of the use or misuse of the transferred files.
D. It is understood and agreed that the items transmitted are prepared from CAD files current at the time of preparation. All files are [AutoCAD version 2018 dwg files].
E. This information does not waive the need to verify and review current field conditions and the status of Addenda and/or Bulletin documentation.
F. As a record of information to be transmitted, TMP Architecture, Inc. will prepare a duplicate electronic back-up for its record.
G. Compensation for providing this material will be as follows:
    1. Base Fee of [$250] for 1 to 3 Drawings.
    2. Base Fee of [$500] for 4 to 10 Drawings.
H. For each additional Drawing after 10 the fee is [$40] per Drawing.
I. Example: [11 drawings = $540].
J. Payment must be provided along with a signed copy of this form before files will be released. Please remit to [Construction Manager] to be forwarded to the Project Manager at TMP Architecture, Inc. and allow five working days for processing.

FEE: $_____
REQUESTED DRAWINGS: _____
_____
_____

FIRM REQUESTING FILES:

Company: _____
Address: _____
Signed:_____Date: _____
Printed Name / Title: _____
Email: _____

TO BE COMPLETED BY TMP ARCHITECTURE, INC.

Released(signed by): _____TMP Architecture, Inc.
Printed Name/Title:_____ Date: _____

END OF SECTION 00 8200.01

SECTION 00 8200 - AVAILABILITY OF ELECTRONIC FILES

AVAILABILITY OF ELECTRONIC FILES

1.01 POLICY

A. As a service to Contractor, subcontractors, vendors, material suppliers and others needing electronic copies of Drawings, the Architect will provide CAD files electronically in accordance with the following policy:

1. By acceptance it is understood and agreed that the data and medium being supplied is to be used only for the project referenced.
2. It is further understood and agreed that the undersigned will hold TMP Architecture, Inc. and its Consultants harmless and indemnify TMP Architecture, Inc. and its Consultants from all claims, liabilities, losses, and so forth, including attorney's fees arising out of the use or misuse of the transferred files.
3. It is understood and agreed that the files transmitted are prepared from CAD files current at the time of preparation. All files are AutoCAD version 2018 dwg files.
4. This information does not waive the need to verify and review current field conditions and the status of Addenda and/or Bulletin documentation.
5. As a record of information to be transmitted, TMP Architecture, Inc. will prepare a duplicate electronic back-up for its record.
6. Compensation Fee for providing this material will be as follows:
   a. Base Fee of $250 for 1 to 3 Drawings.
   b. Base Fee of $500 for 4 to 10 Drawings.
   c. For each additional Drawing after 10, the fee is $40 per Drawing.
      1) Example: 11 Drawings = $540.
7. A signed copy of the Release Form and Fee must be provided before files will be released.

1.02 REQUEST PROCEDURE

A. To receive Drawing CAD files the Release Form must be completed in full and submitted to the Construction Manager to be forwarded to the Project Manager at TMP Architecture, Inc.

1. A signed copy of the Release Form must be submitted.
   a. Faxed or emailed copies will be accepted.
2. Upon remittance of the signed Release Form and Fee, allow five working days for processing.
3. Transmission of Drawings will be provided electronically after the receipt of Fee.

1.03 RELEASE FORM

A. Release Form is located immediately after this Section. Refer to Section 00 8200.01 Electronic Files Release Form.

END OF SECTION 00 8200

SECTION 01 0005 - RELATED REQUIREMENTS

PART 1 GENERAL

1.01 DIVISION 00 AND DIVISION 01

A. Unless otherwise noted, all provisions of sections and documents in Division 00 and Division 01, including, but not limited to, General Conditions and Supplementary Conditions, relate and apply to all sections and documents within Project Manual; including, but not limited to, sections and documents in Division 00 through Division 48.

1.02 DRAWINGS

A. Unless otherwise noted, Drawings relate and apply to all specification sections and documents within Project Manual; including, but not limited to, sections and documents in Division 00 through Division 48.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION -- NOT USED

END OF SECTION 01 0005

SECTION 01 2300 - ALTERNATES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Description of Alternates.

1.02 ACCEPTANCE OF ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner-Contractor Agreement.

B. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

1.03 SCHEDULE OF ALTERNATES

A. Alternate 1 - Batting Cages:

1. Base Bid: No Batting Cages on the Mezzanine Level.
2. Alternate: Provide and instal Batting Cages on the Mezzanine Level completes with separate Control Station all as specified in Specification Section 11 6623.

B. Alternate 2 - Turf Shock Pad

1. Base Bid: To install Turf System without shock pad.
2. Alternate: To provide and install Brock shock pad within the Turf assembly as indicated.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 2300

SECTION 01 2500.01 - TMP SUBSTITUTION REQUEST FORM

SUBSTITUTION REQUEST NUMBER: _____ DATE SUBMITTED: _____
TMP PROJECT NUMBER: 25026E PROJECT NAME: NEW DEXTER HIGH SCHOOL FIELD HOUSE

SPECIFIED ITEM

SPECIFICATION TITLE:_____
SPECIFICATION SECTION_____SPECIFICATION ARTICLE/PARAGRAPH: _____
SPECIFIED PRODUCT / DESCRIPTION: _____
SPECIFIED MANUFACTURER: _____
SPECIFIED PRODUCT / MODEL: _____
REASON SPECIFIED ITEM CANNOT BE PROVIDED: _____
_____
_____

PROPOSED SUBSTITUTION

DESCRIPTION OF PROPOSED SUBSTITUTION: _____
_____
PROPOSED MANUFACTURER: _____
ADDRESS: _____
WEBSITE: _____
PRODUCT / MODEL: _____
YEARS PRODUCT/MODEL HAS BEEN MANUFACTURED: _____
DIFFERENCES BETWEEN PROPOSED SUBSTITUTION AND SPECIFIED ITEM: _____
_____
_____
_____
_____
WILL PROPOSED SUBSTITUTION AFFECT OTHER PARTS OF WORK? ☐ NO ☐ YES
IF YES, EXPLAIN HOW: _____
_____
_____
_____
HOW WILL SUBSTITUTION BENEFIT THE OWNER: ☐ COST SAVINGS ☐ TIME SAVINGS ☐ OTHER
PROVIDE SPECIFIC DETAILS: _____
_____
_____
_____

THE FOLLOWING INFORMATION IS REQUIRED; CHECK TO INDICATE INFORMATION IS ATTACHED. (REQUEST WILL BE REJECTED WITHOUT REQUIRED DATA)

32.01

A. ☐ List of references where proposed product has been installed; include address, owner, architect, and date installed.
B. ☐ Product data sheets.
C. ☐ Applicable certificates and test reports.

D. ☐ Comparative Data: Provide point-by-point, side-by-side comparison of specified product and proposed substitution addressing essential attributes specified.

INDICATE WHICH OF THE FOLLOWING VOLUNTARY INFORMATION IS ATTACHED, IF ANY:
☐ DRAWINGS.
☐ SAMPLES.
☐ OTHER ITEMS: _____

SIGNATURE

THE UNDERSIGNED CERTIFIES:

The proposed substitution meets or exceeds the quality level of the specified product, equipment, assembly, or system.
To provide the same warranty for the substitution as for the specified product.
Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
The proposed substitution will have no adverse effects on other work.
The proposed substitution will not affect project schedule.
Waives claims for additional costs or time extension that may subsequently become apparent.

CONTRACTOR / COMPANY: _____
SIGNED BY: _____PRINTED NAME: _____
TITLE: _____
ADDRESS: _____
EMAIL: _____ PHONE: _____

ARCHITECT'S RESPONSE

A. During bidding, Architect will approve substitution requests by issuing an Addendum. Substitutions not approved by addendum are rejected.
B. During construction, Architect will notify Contractor in writing (see below) of decision to accept or reject request, and incorporate the substitution into the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments as provided for in the Conditions of the Contract.

☐ SUBSTITUTION APPROVED - PROVIDE SUBMITTALS PER SECTION 01 3000 AND RESPECTIVE SECTION FOR WHICH SUBSTITUTION WAS MADE.
☐ SUBSTITUTION REJECTED - PROVIDE SPECIFIED MATERIALS.

SIGNED BY: _____PRINTED NAME: _____
ARCHITECT'S COMMENTS: _____
_____
_____

END OF SECTION 01 2500.01

SECTION 01 2500 - SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

A. Section 01 2500.01 - TMP Substitution Request Form.

1.03 DEFINITIONS

A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.
   1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
   2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.

B. Substitutions: Any proposed substitution to be evaluated by the Architect and accepted as stipulated below.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
   4. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
   5. Waives claims for additional costs or time extension that may subsequently become apparent.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
   1. Note explicitly any non-compliant characteristics.

C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
   1. Forms included in the Project Manual are adequate for this purpose, and must be used.

D. Limit each request to a single proposed substitution item.
   1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

A. Submittal Time Restrictions:

B. Substitution Request Form: TMP Substitution Request Form must be completed and provided at the beginning of each substitution request.
   1. Refer to Section 01 2500.01 - TMP Substitution Request Form.
   2. Submittals without a completed TMP Substitution Request Form will not be acknowledged, reviewed, or returned. Use only this form; other forms of submission are unacceptable.

C. Instructions to Bidders specifies time restrictions for submitting requests for substitutions during the bidding period.

3.03 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

A. Substitution Request Form: TMP Substitution Request Form must be completed and provided at the beginning of each substitution request.

1. Refer to Section 01 2500.01 - TMP Substitution Request Form.
2. Submittals without a completed TMP Substitution Request Form will not be acknowledged, reviewed, or returned. Use only this form; other forms of submission are unacceptable.

B. Submit request for Substitution for Cause immediately upon discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.

C. Submit request for Substitution for Convenience within 14 days of discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.

1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.
2. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
3. Bear the costs engendered by proposed substitution of:
   a. Owner's compensation to the Architect for any required redesign, time spent processing and evaluating the request.
   b. Other unanticipated project considerations.

D. Substitutions will not be considered under one or more of the following circumstances:

1. When they are indicated or implied on shop drawing or product data submittals, without having received prior approval.
2. Without a separate written request.

3.04 RESOLUTION

A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.

B. Architect will notify Contractor in writing of decision to accept or reject request.

1. During construction, Architect's decision following review of proposed substitution will be noted on the submitted form.
2. During bidding, Architect will approve substitution requests by issuing an Addendum. Substitutions not approved by addendum are rejected.

3.05 ACCEPTANCE

A. Accepted substitutions change the work of the Project. They will be documented and incorporated into work of the project by Change Order, Construction Change Directive, Architectural Supplementary Instructions, or similar instruments provided for in the Conditions of the Contract.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

END OF SECTION 01 2500

SUBMITTAL AND SAMPLE TRANSMITTAL FORM

01 3000.01

CONST. MANAGER / CONTRACTOR	PROJECT	TMP PROJECT NO.	DATE SUBMITTED	SUBMITTAL NO.
Name and Address:	Title:	25026E		
	Dexter High School – New Field House	* ACTION CODES		Initial Submittal ☐
		R Reviewed – No Exceptions Taken		Resubmittal ☐
		RN Reviewed with Corrections Noted		
Email:	Location:	RR Revise and Resubmit		REVIEWED BY
	2200 North Parker Road Dexter, MI 48130	X Not Approved – Resubmit		TMP ☐
Phone:		NA No Action Taken – Not Reviewed		Consultant ☐
				Reviewer:

SPECIFICATION SECTION NO.	SUBCONTRACTOR / MANUFACTURER	ITEM DESCRIPTION	NO. OF SAMPLES	NO. OF SAMPLES RETURNED	ACTION CODE *	DATE REVIEWED	DATE RETURNED
Transmittal shall be for one specification section only; do not submit items from multiple sections under the same transmittal. Multi-section submittals will be returned; stamped "X - Not Approved - Resubmit"							

Submittal Stamps may be placed on subsequent blank page.

CONTRACTOR COMMENTS	ARCHITECT COMMENTS	The undersigned certifies that the above submitted items have been reviewed in detail and are correct and in strict conformance with the Contract Documents except as otherwise noted. NOTE: Approval of items submitted does not relieve Contractor from complying with all requirements of the Contract Documents.
		CONTRACTOR NAME
		SIGNATURE

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SECTION 01 3000 - ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittals for review, information, and project closeout.
B. Number of copies of submittals.
C. Requests for Interpretation (RFI) procedures.
D. Submittal procedures.

1.02 RELATED REQUIREMENTS

A. Section 01 3000.01 - TMP Submittal and Sample Transmittal Form.

1.03 REFERENCE STANDARDS

A. AIA G716 - Request for Information; 2004.
B. CSI/CSC Form 13.2A - Request for Information; Current Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 REQUESTS FOR INTERPRETATION (RFI)

A. Definition: A request seeking one of the following:
   1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
   2. A resolution to an issue which has arisen due to field conditions and affects design intent.
B. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
   1. Prepare a separate RFI for each specific item.
      a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
      b. Do not forward requests which solely require internal coordination between subcontractors.
   2. Prepare in a format and with content acceptable to Architect. Use one of the following:
      a. Use AIA G716 - Request for Information .
      b. Use CSI/CSC Form 13.2A - Request for Interpretation.
      c. Other format acceptable to Architect.
   3. Combine RFI and its attachments into a single electronic file. PDF format is preferred.
   4. Submit RFIs through Procore, email, or other approved method agreed to by the Architect and Owner.
      a. RFIs submitted via an internet-based submittal service are to send electronic documents to the Architect via email with a downloadable link.
C. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
   1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
   2. Improper RFIs: Requests not prepared in conformance to requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response and may include an explanatory notation.
   3. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, the Contract Documents, with no additional input required to clarify the question. They will be returned without a response and may include an explanatory notation.

a. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.

D. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
1. Official Project name and number, and any additional required identifiers established in Contract Documents.
2. Discrete and consecutive RFI number, and descriptive subject/title.
3. Issue date, and requested reply date.
4. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
5. Annotations: Field dimensions and/or description of conditions which have engendered the request.
6. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

E. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

F. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
1. Indicate current status of every RFI. Update log promptly and on a regular basis.
2. Note dates of when each request is made, and when a response is received.
3. Identify and include improper or frivolous RFIs.

G. Review Time: Architect will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 3:00 PM will be considered as having been received on the following regular working day.
1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.

H. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
4. Notify Architect within seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.02 SUBMITTAL SCHEDULE

A. Submit to Architect for review a schedule for submittals in tabular format.
1. Submit at the same time as the preliminary schedule.
2. Coordinate with Contractor's construction schedule and schedule of values.
3. Format schedule to allow tracking of status of submittals throughout duration of construction.
4. Arrange information to include scheduled date for initial submittal, specification number and title, description of item of work covered, and role and name of subcontractor.

5. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
    a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

3.03 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
    1. Product data.
    2. Shop drawings.
    3. Samples for selection.
    4. Samples for verification.
B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
C. Samples will be reviewed for aesthetic, color, or finish selection.
D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 7800 - Closeout Submittals.

3.04 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
    1. Design data.
    2. Certificates.
    3. Test reports.
    4. Inspection reports.
    5. Manufacturer's instructions.
    6. Manufacturer's field reports.
    7. Other types indicated.
B. Submit for Architect's knowledge as contract administrator or for Owner.

3.05 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.
B. Submit Final Correction Punch List for Substantial Completion.
C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 7800 - Closeout Submittals:
    1. Project record documents.
    2. Operation and maintenance data.
    3. Warranties.
    4. Other types as indicated.
D. Submit for Owner's benefit during and after project completion.

3.06 NUMBER OF COPIES OF SUBMITTALS

A. Electronic Documents: Submit one electronic copy.
B. Samples: Submit the number specified in individual specification sections, but not less than 3; one (minimum) of which will be retained by Architect.
    1. After review, produce duplicates.
    2. Retained samples will not be returned to Contractor unless specifically so stated.

3.07 SUBMITTAL PROCEDURES

A. Transmittal Form: TMP Submittal and Sample Transmittal Form must be completed and provided at the beginning of each submittal.
    1. Refer to Section 01 3000.01 - TMP Submittal and Sample Transmittal Form.
    2. Submittals without a completed TMP Submittal and Sample Transmittal Form will not be acknowledged, reviewed, or returned.
B. Submittals shall be submitted in electronic form.
    1. Exceptions: Physical samples.

a. Physical Samples must be accompanied by an electronic copy and a hard/physical copy of the completed TMP Submittal and Sample Transmittal Form.

C. Electronic Submittals: Comply with the following:
1. Submittal process shall be through Procore, email, or other approved method agreed to by the Architect and Owner.
a. Submittals via an internet-based submittal service are to send electronic documents to the Architect via email with a downloadable link.
2. File Format: Portable Document Format (PDF).
3. File Naming: File naming shall be in the following format:
a. Specification section number, followed by a hyphen, and a consecutive number indicating sequential submittals for that section; followed by a general description of the submittal contents.
1) Examples:
(a) Section 07 9200; first submittal:
(1) 07 9200-01 Joint Sealants
(b) Section 07 9200; second submittal:
(1) 07 9200-02 Joint Sealant Color
b. Resubmittals. For revised resubmittals use original number and a sequential combination numerical and alphabetical suffix; hyphen followed by "R" and a two-digit consecutive number indicating sequential resubmittals for that particular submittal.
1) Examples:
(a) Section 07 9200; resubmittal of first submittal of section:
(1) 07 9200-01-R01 Joint Sealants.
(b) Section 07 9200; second resubmittal of first submittal of section:
(1) 07 9200-01-R02 Joint Sealants
(c) Section 07 9200; first resubmittal of second submittal of section:
(1) 07 9200-02-R01 Joint Sealant Color
4. Each Submittal shall be one file, complete with all attachments.
a. Multi-file submittal will not be acknowledged, reviewed, or returned.

D. General Requirements:
1. Use a single transmittal for related items.
a. Each transmittal shall be for one specification section only; do not submit items for multiple sections under the same transmittal.
1) Multi-section submittals will be acknowledged and returned; stamped "X - Not Approved - Resubmit".
2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
3. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
4. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
5. Schedule submittals to expedite the Project, and coordinate submission of related items.
a. For each submittal for review, allow 14 calendar days excluding delivery time to and from the Contractor.
b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 7 calendardays.
6. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
7. When revised for resubmission, identify all changes made since previous submission.
8. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.

9. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
10. Submittals not requested will be recognized and returned; stamped "NA - No Action Taken - Not Reviewed"

E. Product Data Procedures:
1. Submit only information required by individual specification sections.
2. Collect required information into a single submittal.
3. Submit concurrently with related shop drawing submittal.
4. Do not submit (Material) Safety Data Sheets for materials or products unless specifically called for in individual sections.

F. Shop Drawing Procedures:
1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
2. Do not reproduce Contract Documents to create shop drawings.
3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.
4. Non-complying submittals will be acknowledged and returned; stamped "X - Not Approved - Resubmit".

G. Samples Procedures:
1. Transmit related items together as single package.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.
3. Submit actual physical samples.
4. Electronic submittals will not be accepted unless prior approval is received from the Architect. Electronic samples without prior approval will be acknowledged and returned; stamped "X - Not Approved - Resubmit."

3.08 SUBMITTAL REVIEW

A. General: Submittals that do not conform to the requirements of this section will not be acknowledged, reviewed, or returned.

B. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.

C. Submittals for Information: Architect will acknowledge and may review. See below for actions to be taken.

D. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
1. Where more than one action has been indicated, each shall apply to that portion of the submittal for which the action is indicated.

E. Architect's review shall not indicate approval of dimensions, quantities or fabrication processes unless specific notations are made by the Architect regarding same.

F. Architect's and consultants' actions on items submitted for review:
1. Authorizing purchasing, fabrication, delivery, and installation:
   a. "Reviewed - No Exceptions Taken", "Approved", or language with same legal meaning.
   b. "Reviewed with Corrections Noted", "Approved as Noted, Resubmission not required", or language with same legal meaning.
      1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
2. Not Authorizing fabrication, delivery, and installation:
   a. "Revise and Resubmit", "Not Approved - Resubmit", or language with the same legal meaning.
      1) Resubmit revised item, with review notations acknowledged and incorporated.
3. Not Authorizing manufacturer:
   a. Rejected - Resubmit, or language with the same legal meaning.

G. Architect's and consultants' actions on items submitted for information:
   1. Items for which no action was taken:
      a. "No Action Taken - Not Reviewed" or "Received" - to notify the Contractor that the submittal has been received for record only.

END OF SECTION 01 3000

SECTION 01 4000 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittals.
B. Quality assurance.
C. References and standards.
D. Testing and inspection agencies and services.
E. Contractor's design-related professional design services.
F. Control of installation.
G. Mock-ups.
H. Tolerances.
I. Manufacturers' field services.
J. Defect Assessment.

1.02 REFERENCE STANDARDS

A. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2025a.
B. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2026.
C. ASTM E699 - Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components; 2016.

1.03 DEFINITIONS

A. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.
    1. Design Services Types Required:
        a. Design-Related: Design services explicitly required to be performed by another design professional due to highly-technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.
B. Design Data: Design-related, signed and sealed drawings, calculations, specifications, certifications, shop drawings and other submittals provided by Contractor, and prepared directly by, or under direct supervision of, appropriately licensed design professional.

1.04 CONTRACTOR'S DESIGN-RELATED PROFESSIONAL DESIGN SERVICES

A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.
B. Base design on performance and/or design criteria indicated in individual specification sections.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.
    1. Include a statement or certification attesting that design data complies with criteria indicated, such as building codes, loads, functional, and similar engineering requirements.
    2. Include signature and seal of design professional responsible for allocated design services on calculations and drawings.
C. Test Reports: After each test/inspection, promptly submit 1 copies of report to Architect and to Contractor.
    1. Include:
        a. Date issued.
        b. Project title and number.

c. Name of inspector.
d. Date and time of sampling or inspection.
e. Identification of product and specifications section.
f. Location in the Project.
g. Type of test/inspection.
h. Date of test/inspection.
i. Results of test/inspection.
j. Compliance with Contract Documents.
k. When requested by Architect, provide interpretation of results.

2. Test report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

D. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.
1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.

E. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

F. Manufacturer's Field Reports: Submit reports for Architect's benefit as contract administrator or for Owner.
1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications:
1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time specialist and responsible officer.

B. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.07 REFERENCES AND STANDARDS

A. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.

B. Obtain copies of standards where required by product specification sections.

C. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

1.08 TESTING AND INSPECTION AGENCIES AND SERVICES

A. As indicated in individual specification sections, Owner or Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.

B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

C. Contractor Employed Agency:
1. Testing agency: Comply with requirements of ASTM E329, ASTM E543, and ASTM E699.
2. Inspection agency: Comply with requirements of ASTM E329.
3. Laboratory Staff: Maintain a full time specialist on staff to review services.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
B. Comply with manufacturers' instructions, including each step in sequence.
C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
E. Have work performed by persons qualified to produce required and specified quality.
F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 MOCK-UPS

A. Before installing portions of the Work where mock-ups are required, construct mock-ups in location and size indicated for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work. The purpose of mock-up is to demonstrate the proposed range of aesthetic effects and workmanship.
B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.
C. Integrated Exterior Mock-ups: Construct integrated exterior mock-up as indicated on drawings. Coordinate installation of exterior envelope materials and products as required in individual Specification Sections. Provide adequate supporting structure for mock-up materials as necessary.
D. Notify Architect 5 working days in advance of dates and times when mock-ups will be constructed.
E. Provide supervisory personnel who will oversee mock-up construction. Provide workers that will be employed during the construction at Project.
F. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.
G. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
H. Obtain Architect's approval of mock-ups before starting work, fabrication, or construction.
    1. Make corrections as necessary until Architect's approval is issued.
I. Architect will use accepted mock-ups as a comparison standard for the remaining Work.
J. Where mock-up has been accepted by Architect and is specified in product specification sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

3.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect before proceeding.
C. Adjust products to appropriate dimensions; position before securing products in place.

3.04 TESTING AND INSPECTION

A. See individual specification sections for testing and inspection required.

B. Testing Agency Duties:
   1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests/inspections specified.

C. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.
   3. Agency may not assume any duties of Contractor.
   4. Agency has no authority to stop the Work.

D. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.
      d. To provide storage and curing of test samples.
   4. Notify Architect and laboratory 48 hours prior to expected time for operations requiring testing/inspection services.
   5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
   6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

E. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.

F. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.05 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.06 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not complying with specified requirements.

B. If, in the opinion of Architect, it is not practical to remove and replace the work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION 01 4000

SECTION 01 4100 - REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY OF REFERENCE STANDARDS

A. Regulatory requirements applicable to this project are the following:
   1. ASHRAE Std 90.1 I-P-2019 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2019, with Errata and Addenda (2021).
   2. Barrier Free Code: Comply with the following:
      a. Michigan Building Code; 2021.
      b. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
   3. School Fire Safety Rules: Michigan School Fire Safety Rules; 2016.
      a. Includes NFPA 101-2012 - Life Safety Code; 2012, plus amendments.
   4. Building Code: Michigan Building Code; 2021.
   5. Plumbing Code: Michigan Plumbing Code; 2021.
   6. Mechanical Code: Michigan Mechanical Code; 2021.
   7. Electrical Code: NFPA 70 - National Electric Code; 2023.
      a. Includes 2023 Michigan Construction Code - Part 8 Electrical Code Rules.
   8. Elevator Code: Comply with the following:
      a. ASME A17.1 - Safety Code for Elevators and Escalators; 2016.
      b. ASME A18.1- Safety Standard for Platform Lifts and Stairway Chairlifts; 2017.
      c. 2023 Michigan Elevator Safety Board General Rules.
   9. Boiler Code: Michigan Boiler Code.
      a. Includes the following:
         1) ASME Boiler and Pressure Vessel Codes; 2019.
         2) National Board Inspection Code; 2019.
         3) PA 407 Skilled Trades Regulation Act; 2016.
   10. Energy Code: Michigan Commercial Energy Code; 2021.
      a. Includes ASHRAE Std 90.1 I-P-2019 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2019.
   11. Existing Building Code: Michigan Rehabilitation Code; 2021.

B. Where specification sections reference more current standards or codes, comply with the more restrictive requirements unless notified in writing by Architect.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 4100

SECTION 01 4216 - DEFINITIONS

PART 1 GENERAL

1.01 SUMMARY

A. This section supplements the definitions contained in the General Conditions.

B. Other definitions are included in individual specification sections.

1.02 DEFINITIONS

A. Furnish: To supply, deliver, unload, and inspect for damage.

B. Install: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use.

C. Product: Material, machinery, components, equipment, fixtures, and systems forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never before used, or re-used materials or equipment.

D. Project Manual: The book-sized volume that includes the procurement requirements (if any), the contracting requirements, and the specifications.

E. Provide: To furnish and install.

F. Supply: Same as Furnish.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 4216

SECTION 01 4219 - REFERENCE STANDARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements relating to referenced standards.

1.02 QUALITY ASSURANCE

A. For products or workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Comply with the reference standard of date of issue , except where a specific date is established by applicable code.

C. Should specified reference standards conflict with Contract Documents, request clarification from the Architect before proceeding.

D. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the Architect shall be altered by Contract Documents by mention or inference otherwise in any reference document.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION -- NOT USED

END OF SECTION 01 4219

SECTION 01 4533 - CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Code-required special inspections.
B. Submittals.

1.02 ABBREVIATIONS AND ACRONYMS

A. AHJ: Authority having jurisdiction.
B. NIST: National Institute of Standards and Technology.

1.03 DEFINITIONS

A. Code or Building Code: Michigan Building Code; 2021, specifically Chapter 17 - Special Inspections and Tests.
B. Authority Having Jurisdiction (AHJ): Agency or individual officially empowered to enforce the building, fire and life safety code requirements of the permitting jurisdiction in which the Project is located.
C. Special Inspection:
   1. Special inspections are inspections and testing of materials, installation, fabrication, erection or placement of components and connections mandated by the AHJ that also require special expertise to ensure compliance with the approved Contract Documents and the referenced standards.
   2. Special inspections are separate from and independent of tests and inspections conducted by Owner or Contractor for the purposes of quality assurance and contract administration.

1.04 REFERENCE STANDARDS

A. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2025a.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Special Inspection Agency Qualifications: Prior to the start of work, the Special Inspection Agency is required to:
   1. Submit agency name, address, and telephone number, names of full time specialist and responsible officer.
   2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
   3. Submit certification that Special Inspection Agency is acceptable to AHJ.
C. Special Inspection Reports: After each special inspection, Special Inspector is required to promptly submit at least two copies of report; one to Architect and one to the AHJ.
   1. Include:
      a. Date issued.
      b. Project title and number.
      c. Name of Special Inspector.
      d. Date and time of special inspection.
      e. Identification of product and specifications section.
      f. Location in the Project.
      g. Type of special inspection.
      h. Date of special inspection.
      i. Results of special inspection.
      j. Compliance with Contract Documents.
   2. Final Special Inspection Report: Document special inspections and correction of discrepancies prior to the start of the work.

D. Fabricator Special Inspection Reports: After each special inspection of fabricated items at the Fabricator's facility, Special Inspector is required to promptly submit at least two copies of report; one to Architect and one to AHJ.
   1. Include:
      a. Date issued.
      b. Project title and number.
      c. Name of Special Inspector.
      d. Date and time of special inspection.
      e. Identification of fabricated item and specification section.
      f. Location in the Project.
      g. Results of special inspection.
      h. Verification of fabrication and quality control procedures.
      i. Compliance with Contract Documents.
      j. Compliance with referenced standard(s).

E. Test Reports: After each test or inspection, promptly submit at least two copies of report; one to Architect and one to AHJ.
   1. Include:
      a. Date issued.
      b. Project title and number.
      c. Name of inspector.
      d. Date and time of sampling or inspection.
      e. Identification of product and specifications section.
      f. Location in the Project.
      g. Type of test or inspection.
      h. Date of test or inspection.
      i. Results of test or inspection.
      j. Compliance with Contract Documents.

1.06 SPECIAL INSPECTION AGENCY

A. Owner will employ services of a Special Inspection Agency to perform inspections and associated testing and sampling in accordance with ASTM E329 and required by the building code.

B. Employment of agency in no way relieves Contractor of obligation to perform work in accordance with requirements of Contract Documents.

1.07 QUALITY ASSURANCE

A. Special Inspection Agency Qualifications:
   1. Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SCHEDULE OF SPECIAL INSPECTIONS, GENERAL

A. Frequency of Special Inspections: Special Inspections are indicated as continuous or periodic.
   1. Continuous Special Inspection: Special Inspection Agency is required to be present in the area where the work is being performed and observe the work at all times the work is in progress.
   2. Periodic Special Inspection: Special Inspection Agency is required to be present in the area where work is being performed and observe the work part-time or intermittently and at the completion of the work.

3.02 SPECIAL INSPECTIONS

A. Special inspections and testing shall be for materials, installation, fabrication, erection or placement of components and connections as indicated on Drawings, but not less than that required by the building code.

END OF SECTION 01 4533

SECTION 01 6000 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Re-use of existing products.
B. Transportation, handling, storage and protection.
C. Product option requirements.
D. Substitution limitations.
E. Procedures for Owner-supplied products.
F. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 SUBMITTALS

A. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
B. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
    1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by Contract Documents.
B. Unforeseen historic items encountered remain the property of the Owner; notify Owner promptly upon discovery; protect, remove, handle, and store as directed by Owner.
C. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.
D. Specific Products to be Reused: The reuse of certain materials and equipment already existing on the project site is required.
    1. Refer to Drawings and Section 02 4100 - Demolition.

2.02 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by Contract Documents.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.
D. Available Products: Products specified by naming one or more Manufacturers as an Available Product indicates that these Manufacturers' products may be provided but other comparable products and Manufacturers not named may also be provided without submitting a request for substitution.

2.04 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver and place in location as directed; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

A. See Section 01 2500 - Substitution Procedures.

3.02 OWNER-SUPPLIED PRODUCTS

A. Owner's Responsibilities:
   1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
   2. Arrange and pay for product delivery to site.
   3. On delivery, inspect products jointly with Contractor.
   4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
   5. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:
   1. Review Owner reviewed shop drawings, product data, and samples.
   2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
   3. Handle, store, install and finish products.
   4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport and handle products in accordance with manufacturer's instructions.

E. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

F. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

G. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Provide off-site storage and protection when site does not permit on-site storage or protection.

G. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

H. Comply with manufacturer's warranty conditions, if any.

I. Do not store products directly on the ground.

J. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

K. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
L. Prevent contact with material that may cause corrosion, discoloration, or staining.
M. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
N. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 01 6000

SECTION 01 7000 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.
B. Requirements for alterations work, including selective demolition.
C. Pre-installation meetings.
D. Cutting and patching.
E. Surveying for laying out the work.
F. Cleaning and protection.
G. Starting of systems and equipment.
H. Demonstration and instruction of Owner personnel.
I. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.
J. General requirements for maintenance service.

1.02 REFERENCE STANDARDS

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

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
    1. Structural integrity of any element of Project.
    2. Integrity of weather exposed or moisture resistant element.
    3. Efficiency, maintenance, or safety of any operational element.
    4. Visual qualities of sight exposed elements.
    5. Work of Owner or separate Contractor.
    6. Include in request:
        a. Identification of Project.
        b. Location and description of affected work.
        c. Necessity for cutting or alteration.
        d. Description of proposed work and products to be used.
        e. Effect on work of Owner or separate Contractor.
C. Project Record Documents: Accurately record actual locations of capped and active utilities.
D. Warranties: For each affected material under warranty, submit written verification, signed by manufacturer of existing materials, stating that the Owner's full warranty will remain in effect after cutting and patching operations have been completed

1.04 QUALIFICATIONS

A. For surveying work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate. Employ only individual(s) trained and experienced in collecting and recording accurate data relevant to ongoing construction activities,

1.05 PROJECT CONDITIONS

A. Use of explosives is not permitted.
B. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
C. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
D. Perform dewatering activities, as required, for the duration of the project.
E. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

F. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
   1. Provide dust-proof enclosures to prevent entry of dust generated outdoors.
   2. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Owner.

G. Erosion and Sediment Control: Plan and execute work by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
   1. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

H. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
   1. Outdoors: Limit conduct of especially noisy exterior work to the hours of 8 am to 5 pm.
   2. Indoors: Limit conduct of especially noisy interior work to the hours of 6 pm to 7 am.

I. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.

J. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.06 COORDINATION

A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Notify affected utility companies and comply with their requirements.

C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of work of separate sections.

G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.07 WARRANTIES

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
C. Examine and verify specific conditions described in individual specification sections.
D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.
B. Seal cracks or openings of substrate prior to applying next material or substance.
C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
B. Require attendance of parties directly affecting, or affected by, work of the specific section.
C. Notify Architect 5 calendar days in advance of meeting date.
D. Prepare agenda and preside at meeting:
    1. Review conditions of examination, preparation and installation procedures.
    2. Review coordination with related work.
E. Record minutes and distribute copies within two days after meeting to participants, with 1 copies to Architect, Owner, participants, and those affected by decisions made.

3.04 LAYING OUT THE WORK

A. Verify locations of survey control points prior to starting work.
B. Promptly notify Architect of any discrepancies discovered.
C. Contractor shall locate and protect survey control and reference points.
D. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
E. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
F. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
G. Utilize recognized engineering survey practices.
H. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
    1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
    2. Grid or axis for structures.
    3. Building foundation, column locations, ground floor elevations.
    4. Controlling lines and levels required for mechanical and electrical trades.
I. Periodically verify layouts by same means.

J. Maintain a complete and accurate log of control and survey work as it progresses.

3.05 GENERAL INSTALLATION REQUIREMENTS

A. In addition to compliance with regulatory requirements, conduct construction operations in compliance with NFPA 241, including applicable recommendations in Appendix A.
B. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
C. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
D. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
E. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
F. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation only.
    1. Verify that construction and utility arrangements are as indicated.
    2. Report discrepancies to Architect before disturbing existing installation.
    3. Beginning of alterations work constitutes acceptance of existing conditions.
B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.
    1. Provide, erect, and maintain temporary dustproof partitions.
C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
    1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
    2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.
D. Remove existing work as indicated and as required to accomplish new work.
    1. Remove items indicated on drawings.
    2. Relocate items indicated on drawings.
    3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
    4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove, relocate, and extend existing systems to accommodate new construction.
    1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
    2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
    3. 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.
        a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
        b. Provide temporary connections as required to maintain existing systems in service.
    4. Verify that abandoned services serve only abandoned facilities.

5. 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; patch holes left by removal using materials specified for new construction.

F. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.

G. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
   1. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.

H. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.

I. Refinish existing surfaces as indicated:
   1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
   2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.

J. Clean existing systems and equipment.

K. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.

L. Do not begin new construction in alterations areas before demolition is complete.

M. Comply with all other applicable requirements of this section.

3.07 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. See Alterations article above for additional requirements.

C. Perform whatever cutting and patching is necessary to:
   1. Complete the work.
   2. Fit products together to integrate with other work.
   3. Provide openings for penetration of mechanical, electrical, and other services.
   4. Match work that has been cut to adjacent work.
   5. Repair areas adjacent to cuts to required condition.
   6. Repair new work damaged by subsequent work.
   7. Remove samples of installed work for testing when requested.
   8. Remove and replace defective and non-complying work.

D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

E. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

G. Restore work with new products in accordance with requirements of Contract Documents.

H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 8400, to full thickness of the penetrated element.

J. Patching:

1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
   a. This includes painted surfaces.
   b. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
2. Match color, texture, and appearance.
3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.08 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.09 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.
B. Provide special protection where specified in individual specification sections.
C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.10 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.
B. Notify Architectand Owner 7 calendar days prior to start-up of each item.
C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
E. Verify that wiring and support components for equipment are complete and tested.
F. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.11 DEMONSTRATION AND INSTRUCTION

A. See Section 01 7900 - Demonstration and Training.

B. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.
C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location.
D. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
E. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of Owner's personnel.
F. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

3.12 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.13 FINAL CLEANING

A. Use cleaning materials that are nonhazardous.
B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
E. Clean filters of operating equipment.
F. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, and drainage systems.
G. Clean site; sweep paved areas, rake clean landscaped surfaces.
H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.14 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.
B. Accompany Contractor on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.
C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.
D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.
E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.

H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.15 MAINTENANCE

A. Provide service and maintenance of components indicated in specification sections.

B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.

C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.

E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION 01 7000

SECTION 01 7329 - CUTTING AND PATCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cutting and patching.

1.02 REFERENCE STANDARDS

A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:

1. Structural integrity of any element of Project.
2. Integrity of weather exposed or moisture resistant element.
3. Efficiency, maintenance, or safety of any operational element.
4. Visual qualities of sight exposed elements.
5. Work of Owner or separate Contractor.
6. Include in request:
   a. Location and description of affected work.
   b. Necessity for cutting or alteration.
   c. Description of proposed work and products to be used.
   d. Effect on work of Owner or separate Contractor.

C. Warranties: For each affected material under warranty, submit written verification, signed by manufacturer of existing materials, stating that the Owner's full warranty will remain in effect after cutting and patching operations have been completed.

1.04 WARRANTIES

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

1. Materials that are still under warranty include, but are not limited to, the following:
   a. _____.
   b. _____.
   c. _____.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

B. Prior to Patching: Before patching, verify compatibility and suitability of substrates, including compatibility with existing finishes or primers. Beginning of patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.
C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.
D. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
E. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

3.03 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.
B. Perform whatever cutting and patching is necessary to:
   1. Complete the work.
   2. Fit products together to integrate with other work.
   3. Provide openings for penetration of mechanical, electrical, and other services.
   4. Match work that has been cut to adjacent work.
   5. Repair areas adjacent to cuts to required condition.
   6. Repair new work damaged by subsequent work.
   7. Remove samples of installed work for testing when requested.
   8. Remove and replace defective and non-conforming work.
C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
D. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
E. Cutting:
   1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces.
   2. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
   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.
F. Restore work with new products in accordance with requirements of Contract Documents.
G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 8400 - Firestopping, to full thickness of the penetrated element.
I. Patching:
   1. Repair adjacent construction and finishes damaged during removal work and cutting work.
   2. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
      a. This includes painted surfaces.
      b. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
   3. Match color, texture, and appearance.
   4. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

END OF SECTION 01 7329

SECTION 01 7800 - CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project record documents.
B. Operation and maintenance data.
C. Warranties and bonds.

1.02 SUBMITTALS

A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
B. Operation and Maintenance Data:
   1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
   2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
   3. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
   4. Submit two sets of revised final documents in final form within 10 days after final inspection.
C. Warranties and Bonds:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
   2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
   3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

A. General:
   1. Project Record Documents include:
      a. Complete set of Record Drawings.
      b. Complete set of Record Submittals.
      c. Complete set of Specifications.
   2. Project Record Documents shall be submitted in electronic form.
      a. File Format: Portable Document Format (PDF).
      b. Files shall be named and organized in a searchable, easy to understand, system.
   3. Ensure entries are complete and accurate, enabling future reference by Owner.
   4. Record information concurrent with construction progress.
B. Record Drawings: Record Drawings shall include the following:
   1. Complete set of Drawings.
      a. Indicate and record actual construction including, but not limited to, the following:
         1) Show all systems and assemblies as they exist at completion of the Work.
         2) Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
         3) Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
         4) Field changes of dimension and detail.
         5) Details not on original Contract drawings.
   2. Addenda.
   3. Change Orders and other modifications to the Contract.
C. Record Submittals: Record Submittals shall include the following:

1. Complete set of Submittals, including resubmittals.
2. Shop Drawings shall indicate all field changes and other variations from the Submittal as originally reviewed by Architect.

D. Specifications: Specifications shall include the following:
1. Complete Project Manual including all specifications, front end material, reports, and information available to bidders, as originally bid.
2. Addenda.
3. Change Orders and other modifications to the Contract.

3.02 OPERATION AND MAINTENANCE DATA

A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

A. For Each Product, Applied Material, and Finish:
1. Product data, with catalog number, size, composition, and color and texture designations.

B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.

C. Additional information as specified in individual product specification sections.

D. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

A. For Each Item of Equipment and Each System:
1. Description of unit or system, and component parts.
2. Identify function, normal operating characteristics, and limiting conditions.
3. Include performance curves, with engineering data and tests.
4. Complete nomenclature and model number of replaceable parts.

B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

D. Include color coded wiring diagrams as installed.

E. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

F. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

G. Provide servicing and lubrication schedule, and list of lubricants required.

H. Include manufacturer's printed operation and maintenance instructions.

I. Include sequence of operation by controls manufacturer.

J. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
K. Provide control diagrams by controls manufacturer as installed.
L. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
M. Include test and balancing reports.
N. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. General:
1. Operational and Maintenance Manuals include:
a. Operational and maintenance data.
b. Operational and maintenance data for materials and finishes.
c. Operational and maintenance data for equipment and systems.
2. Operational and Maintenance Manuals shall be submitted both in electronic form and as hard copy/durable manuals.
a. Subject to Owner approval, hard copy/durable manuals may be omitted.
b. Electronic File Format: Portable Document Format (PDF).
1) Files shall be named and organized in a searchable, easy to understand, system similar to the descriptions for the hard copy/durable manuals
B. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
C. Where systems involve more than one specification section, provide separate tabbed divider for each system.
D. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 3 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
E. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
F. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.
G. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
H. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
I. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
J. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
K. Arrangement of Contents: Organize each volume in parts as follows:
1. Project Directory.
2. Table of Contents, of all volumes, and of this volume.
3. Operation and Maintenance Data: Arranged by system, then by product category.
a. Source data.
b. Operation and maintenance data.
c. Field quality control data.
d. Photocopies of warranties and bonds.

3.06 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

E. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.

F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.

G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.

H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION 01 7800

SECTION 01 7900 - DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

A. Demonstration of products and systems to be commissioned and where indicated in specific specification sections.

B. Training of Owner personnel in operation and maintenance is required for:
   1. All software-operated systems.
   2. HVAC systems and equipment.
   3. Plumbing equipment.
   4. Electrical systems and equipment.
   5. Items specified in individual product Sections.

C. Training of Owner personnel in care, cleaning, maintenance, and repair is required for:
   1. Roofing, waterproofing, and other weather-exposed or moisture protection products.
   2. Finishes, including flooring, wall finishes, ceiling finishes.
   3. Fixtures and fittings.
   4. Items specified in individual product Sections.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures; except:

B. Draft Training Plans: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
   1. Submit not less than four weeks prior to start of training.
   2. Revise and resubmit until acceptable.
   3. Provide an overall schedule showing all training sessions.
   4. Include at least the following for each training session:
      a. Identification, date, time, and duration.
      b. Description of products and/or systems to be covered.
      c. Name of firm and person conducting training; include qualifications.
      d. Intended audience, such as job description.
      e. Objectives of training and suggested methods of ensuring adequate training.
      f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
      g. Media to be used, such a slides, hand-outs, etc.
      h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.

C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
   1. Include applicable portion of O&M manuals.
   2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
   3. Provide one extra copy of each training manual to be included with operation and maintenance data.

1.03 QUALITY ASSURANCE

A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
   1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
   2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

B. Coordination: Coordinate demonstration and training of this section with project commissioning requirements.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

B. Demonstrations conducted during Functional Testing need not be repeated unless Owner personnel training is specified.

C. Demonstration may be combined with Owner personnel training if applicable.

D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.

1. Perform demonstrations not less than two weeks prior to Substantial Completion.
2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.

1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

A. Conduct training on-site unless otherwise indicated.

B. Do not start training until Functional Testing is complete, unless otherwise specified or approved by the Commissioning Authority.

C. Provide training in minimum two hour segments.

D. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.

E. Review of Facility Policy on Operation and Maintenance Data: During training discuss:

1. The location of the O&M manuals and procedures for use and preservation; backup copies.
2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
3. Typical uses of the O&M manuals.

F. Product- and System-Specific Training:

1. Review the applicable O&M manuals.
2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
4. Provide hands-on training on all operational modes possible and preventive maintenance.
5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
6. Discuss common troubleshooting problems and solutions.
7. Discuss any peculiarities of equipment installation or operation.
8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
9. Review recommended tools and spare parts inventory suggestions of manufacturers.
10. Review spare parts and tools required to be furnished by Contractor.
11. Review spare parts suppliers and sources and procurement procedures.

G. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION 01 7900

SECTION 01 9113 – COMMISSIONING REQUIREMENTS

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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 work of this section.

B. Related Sections include the following:

1. Division 23 Sections Mechanical.
2. Division 26 Sections Electrical.

1.02 DESCRIPTION

A. Purpose

1. Verify operation and functional performance of the mechanical and electrical systems for compliance with the Owners Project Requirements (OPR) and the Basis of Design (BoD).
2. Document systems tests and inspections.
3. Verify application of operation and maintenance manuals, record documents, spare parts listing, special tools listing and other items as may be specified herein for support of systems and equipment.
4. Coordinate and direct training of personnel for operation and maintenance of equipment and systems.

B. General

1. Furnish labor and material to accomplish complete commissioning as specified herein.
2. Complete interim commissioning of HVAC systems during initial season operation and follow up commissioning of required HVAC systems during additional season operation.

1.03 QUALITY ASSURANCE

A. References: ASHRAE Guideline 0-2019, "The Commissioning Process," Guideline 1.2-2019, " Technical Requirements for The Commissioning Process for Existing HVAC&R Systems and Assemblies." Guideline 1.5-2019, “The Commissioning Process for Smoke Control Systems.” and Standard 202-2018, “Commissioning Process for Buildings and Systems.”

B. International Electrical Testing Association – NETA Acceptance Testing Specifications – ATS–2017.

1.04 **RESPONSIBILITIES**

A. Contractor

1. The Contractor shall assure participation and cooperation of subcontractors (mechanical, electrical, temperature controls, TAB, etc.) under his jurisdiction, and suppliers (air handling units, boilers, pumps, fire alarm, etc.), as required for the commissioning process. *NOTE: PERSONNEL ASSIGNED TO PERFORMING OR PARTICIPATING IN FUNCTIONAL TESTING SHALL HAVE NO OTHER DUTIES OR ASSIGNMENTS DURING THE DURATION OF THE TESTING.*

2. The Contractor shall be responsible for providing labor, material, equipment, etc., required to facilitate the commissioning process.

3. Attend the commissioning meetings (to be held, depending on progress and as required for the systems to be commissioned) which include the Contractor, the Owner, the Commissioning Authority, and appropriate subcontractors and suppliers. The purpose of these meetings shall be to coordinate and schedule commissioning activities. The Contractor shall coordinate the attendance of the appropriate subcontractors and suppliers.

4. Incorporate in the project construction schedule those elements related to commissioning activities.

5. Prepare system test reports (pipe pressure tests, duct pressure/leak tests, etc.), submit to commissioning authority for review, and insert in appropriate location of the commissioning manual.

6. Prepare equipment/system installation and start-up reports for each piece of equipment/system to be commissioned. Submit completed reports to commissioning authority for review and insert reports in appropriate location of the commissioning manual.

7. Maintain and update the cloud based project commissioning manual (CxAlloy). Contractor shall have access to the project commissioning manual used by the commissioning team throughout the project. Contractor shall upload all required test reports prepared by the Contractors, equipment installation reports prepared by the Contractors, and equipment start-up reports prepared by the Contractor under the related asset identification of the cloud based commissioning manual. At the completion of the commissioning process, the Cx Authority shall generate a Final Cx Report and the contractor shall be required to provide any missing information regarding warranty related start-up documentation.

8. Coordinate, schedule and perform start-up and functional testing of equipment and systems. *NOTE: ADDITIONAL TIME OR TRAVEL EXPENSES INCURRED BY THE COMMISSIONING AUTHORITY DUE TO CANCELLED OR POSTPONED TESTING, OR DUE TO EQUIPMENT NOT BEING READY FOR FUNCTIONAL TESTING WHEN SCHEDULED SHALL BE PAID TO THE COMMISSIONING AUTHORITY BY THE CONTRACTOR.*

9. Perform functional tests as directed by the Commissioning Authority. Document functional testing results, noting actual performance versus design requirements. Functional tests will demonstrate operation of every item in the control sequences under all normal operation modes, including part and full load, occupied, unoccupied and emergency conditions.

10. Coordinate the training of Owner personnel. Refer to Division 01 and the individual specification Sections for Owner training requirements. In addition to the Owner training specified in the individual specification Sections, provide two (2) Owner training sessions, each four (4) hours in length, on the operation of the system as a whole.

11. Assemble/develop complete Operations and Maintenance Manuals. A draft copy of the O & M shall be submitted early in project and be available on site during commissioning. Final copy shall be submitted prior to substantial completion of the project.

B. Commissioning Authority:

1. Develop the commissioning manual.
2. Participate in critical construction progress meetings, and review all construction progress meeting notes.
3. The Commissioning Authority shall hold regular commissioning meetings (to be held, depending on progress and as required for the systems to be commissioned). The Commissioning Authority shall schedule the meetings, notify the Owner and the Contractor, and record and submit minutes from these meetings to the Owner for distribution to the Contractor.
4. Participate in the review of document clarification requests.
5. Participate in the review of field orders and bulletins.
6. Participate in compliance reviews of submittal documents (shop drawings and submittals).
7. Provide construction progress observations, with documentation and recommendations to the Owner's Project Construction Representative.
8. Verify testing by witnessing the tests, or verify testing by reviewing documentation of testing witnessed by others.
9. Participate in the observation and review of functional tests on systems being commissioned.
10. Review final record documents (i.e., operation and maintenance manuals, as-built drawings, etc.).

C. Owner:

1. Establish contracts:
   a. Owner-Engineer Agreement for design.
   b. Owner-Contractor Contract for construction.
   c. Owner-Commissioning Authority Agreement for observation and review of the commissioning process.
2. Attend the commissioning meetings.
3. Verify testing by witnessing the tests, or verify testing by reviewing documentation of testing witnessed by others.
4. Participate in the observation and review of functional tests on systems being commissioned.
5. Review final record documents (i.e., operation and maintenance manuals, as-built drawings, etc.).
6. Participate in Owner Training provided by the Contractor.

1.05 **SUBMITTALS**

A. Submit under provisions of Division 01 and as supplemented in this section.

B. Prepare system test reports (pipe pressure tests, duct pressure/leak test, electrical tests, etc.), submit to commissioning authority for review, and insert in appropriate location of the commissioning manual.

C. Prepare equipment/system installation and start-up reports for each piece of equipment/system to be commissioned. Submit completed reports to commissioning authority for review and insert reports in appropriate location of the commissioning manual.

D. The Contractor shall submit Owner training plans.

E. The Contractor shall show in the Project schedule the order and timing of the Commissioning Plan for each of the systems to be commissioned.

F. Draft copy of the project O & M manuals shall be submitted early in the construction phase and be available on site for use during commissioning.

1.06 **PROJECT RECORD DOCUMENTS**

A. Submit electronic copies of the as-built Commissioning Manual after completion of commissioning. As-built Commissioning Manual shall include:

1. Completed (initialed) Commissioning Plan/Sign-off List for each system which was commissioned.
2. As-built description of operation for each system which was commissioned.
3. Completed (checked-off) functional test plan/checklist for each system which was commissioned.
4. Piping system certified pressure test report (where applicable) for each system which was commissioned.
5. Piping system flushing and cleaning report (where applicable) for each system which was commissioned.
6. Inspection Certificates (where applicable) for each system which was commissioned.
7. Manufacturer on-site start-up test reports (where applicable) for equipment of commissioned systems.
8. Documentation of the dates and times during which Owner training took place for each system which was commissioned.

PART 2 PRODUCTS

2.01 **INSTRUMENTATION**

A. Instrumentation shall be provided by the Contractor performing tests.

PART 3 EXECUTION

3.01 **SYSTEMS/EQUIPMENT TO BE COMMISSIONED**

A. Mechanical Systems:

1. Gas Fired Hot Water Boilers (B-1 & B-2)
2. Heating Hot Water Pumps (CP-3 & CP-4)
3. Geothermal Heat Pump Loop Circulation Pumps (CP-1 & CP-2)
4. Water Source Heat Pumps (Alts. 1 and 3)
5. Water to Water Heat Exchanger (HX-1)
6. Air Handling Unit (AHU-1)
7. Energy Recovery Unit (ERU-1)
8. Air Terminal Units (sample 25% of VAV’s)

9. Humidifiers (H-1 & H-2)
10. Exhaust Fans (EF-1 through EF-5)
11. Split Systems Air Conditioning Unit (ACU-1 thru ACU-4 & CU-5)
12. Unit Heaters (UH-1 thru UH-3)
13. Electric Unit Heaters (EUH-1 thru EUH-4)
14. Cabinet Unit Heaters (CUH-1 through CUH-5)
15. Finned Tube Radiators (FTR-1 through FTR-4)
16. Panel Radiators (PR-1)
17. Domestic Water Heaters (EWH-1 & DWH-1)
18. Domestic Water Recirculation Pump (CP-5)
19. Sump Pumps (SP-1 & SP-2)

B. Electrical Systems:

1. Lighting Controls

3.02 **COMMISSIONING PLAN**

A. The following is a general outline of the commissioning plan. It includes, but is not limited to the following items, as applicable:

1. Submit shop drawings and product data.
2. Submit Commissioning Manuals for review, prior to beginning the commissioning process. Refer to the "SUBMITTALS" portion of this section for requirements.
3. Submit draft copies of Operations and Maintenance manuals for review.
4. Submit Training Plan.
5. Submit verification that all pressure testing, flushing and cleaning has been completed for piping systems.
6. Submit Inspection Certificates.
7. Submit verification of start-up tests for equipment and systems.
8. Submit air and water balance report.
9. Complete testing of the functional performance of all components of each system to be commissioned. (Note Requirements in paragraph 1.04.A.9 in this section)
10. Any test which cannot be accomplished for seasonal or other reasons, or for which acceptable performance is not achieved, shall be rescheduled to a time when it can be accomplished.
11. Participate in substantial completion walk-through.
12. Submit warranties.
13. Submit record documents, including but not limited to as-built drawings, final operations and maintenance manuals and completed Commissioning Manual.
14. Conduct training of Owner personnel.

B. At the end of the process, every mode of the commissioned systems operation, all commissioned system equipment and components, and every item in the control sequences shall have been proven operational under all normal operational modes, including part and full load, and under normal and emergency conditions.

END OF SECTION

SECTION 03 3000 – CAST IN PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.03 INFORMATIONAL SUBMITTALS

A. Material certificates

B. Material test reports

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1.05 PRECONSTRUCTION TESTING

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

1.06 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.07 FIELD CONDITIONS

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

B. Hot-Weather Placement: Comply with ACI 301.

PART 2 PRODUCTS

2.01 CONCRETE, GENERAL

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

2.02 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.03 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

2.04 CONCRETE MATERIALS

A. Cementitious Materials:
   1. Portland Cement: ASTM C 150/C 150M, Type I, gray.
   2. Fly Ash: ASTM C 618, Class F or C.
   3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.
   1. Maximum Coarse-Aggregate Size: 1 inch nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Lightweight Aggregate: ASTM C330/C330M 3/4-inch nominal maximum aggregate size.

D. Air-Entraining Admixture: ASTM C 260/C 260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Refer to 03 3003 for Moisture Vapor Reducing Admixture.

F. Water: ASTM C 94/C 94M and potable.

2.05 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

B. Water: Potable.

C. All interior slab on grade concrete shall be moisture cure only.

2.06 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.07 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing admixture in concrete, as required, for placement and workability.

2.08 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Refer to structural general notes.

2.09 FABRICATING REINFORCEMENT

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

2.10 CONCRETE MIXING

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

B. Moisture Vapor Reduction Admixture (MVRA):
   a. Where required add admixture as recommended in ACI 211.1 and at rates required by manufacturer.

PART 3 EXECUTION

3.01 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.02 EMBEDDED ITEM INSTALLATION

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

3.03 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches and seal with manufacturer's recommended tape.
   2. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings.

3.04 STEEL REINFORCEMENT INSTALLATION

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

3.05 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

3.06 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3.07 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:

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

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

3.08 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
   1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
   1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
   2. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinnest method. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.09 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

3.10 CONCRETE SURFACE REPAIRS

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

3.11 FIELD QUALITY CONTROL

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

B. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
(a) One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

END OF SECTION

SECTION 03 3003 - CAST-IN-PLACE CONCRETE REQUIREMENTS FOR FLOOR SLABS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Underslab vapor retarder.
B. Moisture vapor reduction admixture (MVRA) for cast-in-place concrete floor slabs receiving moisture sensitive floor finishes.
C. Reinforcing and jointing requirements for cast-in-place concrete floor slabs receiving hard tile floor finishes.
D. Floor flatness and levelness tolerances; slabs on grade and suspended slabs.
E. Liquid densifier/hardener.

1.02 REFERENCE STANDARDS

A. ACI 211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
B. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).
C. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method; 1983 (Reapproved 2018).
D. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).
E. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2018a.
F. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
G. ASTM E1155/E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2023.
H. ASTM E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric); 2014.
I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of floor slab installation and the work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
C. Mix Design: Submit proposed concrete mix design.
D. Field Quality Control Reports: Provide the following:
   1. F(F) Floor Flatness and F(L) Floor Levelness measurements as specified.
E. Submit documentation from manufacturers certifying that curing products and methods are compatible with concrete staining and polishing materials and methods.
F. Manufacturer's Qualification Statement.
G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 5 years of documented experience.

B. Obtain moisture vapor reduction admixture from a single manufacturer.
C. Floor Slab Moisture Content:
   1. Manufacturer and Installer of Athletic Surfacing ackowledge that concrete slabs scheduled to receive Athletic Surfacing products are constructed with concrete mix designs containing water-vapor reducing admixtures.
   2. Manufacturer and Installer of Athletic Surfacing agree to cooperate with the manufacturer of water-vapor reducing admixtures includinbg methods for testing slab moisture content, interpretation of moisture test results, and methods for slab preparation to receive Athletic Surfacing.
   3. Claims for additional compensation based on disagreements arising from interpretation of slab moisture testing will not result in additional costs to the Owner, or be acceptable cause for modificatiuons of warranty (guarantee) requirements included in this section or other sections of the Contract Documents.
D. In addition to requirements of this Section comply with requirements of Section 03 3000 - Cast-in-Place Concrete.
   1. If there is a conflict between sections, comply with the more stringent requirement unless otherwise indicated by Architect.
E. Concrete Curing:
   1. Prior to installing and curing concrete floor slabs to be stained and polished, verify with polished concrete materials manufacturer that curing products and methods are compatible with concrete staining and polishing.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Slabs with Moisture Vapor Reduction Admixture (MVRA): Provide warranty to cover the cost of flooring failures due to moisture migration from slabs for ten years.
   1. Include cost of repair or removal of failed flooring, placement of topical moisture remediation system, and replacement of flooring with comparable flooring system.

PART 2 PRODUCTS

2.01 UNDERSLAB VAPOR RETARDER

A. Underslab Vapor Retarder: Sheet material complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.
   1. Installation: Comply with ASTM E1643.
   2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
   3. Minimum Thickness: 15 mil.
   4. Products:
      a. Fortifiber Building Systems Group: www.fortifiber.com.
      b. Inteplast Group; Barrier-Bac VB-350: www.barrierbac.com.
      c. ISI Building Products; Viper VaporCheck II 15-mil (Class A): www.isibp.com.
      d. Poly-America; Husky Yellow Guard 15-mil Vapor Barrier: www.yellowguard.com.
      e. Stego Industries, LLC; 15 mil: www.stegoindustries.com.
      f. W. R. Meadows, Inc; PERMINATOR Class A - 15 mils: www.wrmeadows.com.
      g. Substitutions: See Section 01 6000 - Product Requirements.

2.02 MOISTURE VAPOR REDUCTION ADMIXTURE

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
B. Moisture Vapor Reduction Admixture (MVRA): ASTM C494/C494M, Type S; liquid, inorganic admixture free of volatile organic compounds (VOCs) and formulated to permanently close capillary systems formed during curing to reduce moisture vapor emission and transmission with no adverse effect on concrete properties or finish flooring.

1. Locations: Provide at concrete floor slabs receiving moisture sensitive floor finishes.
   a. Moisture sensitive floor finishes include the following:
      1) Resilient tile and sheet.
      2) Carpet tile and sheet carpeting.
      3) Wood gymnasium flooring.
      4) Wood stage flooring.
      5) Epoxy matrix terrazzo flooring.
      6) Other adhesive applied floor finishes.
2. Water Vapor Permeance: 0.03 perms, maximum, when tested in accordance with ASTM E96/E96M.
3. Products:
   a. Barrier One, Inc; CPS Admix - Moisture Vapor Reduction Admixture (MVRA): www.barrierone.com.
   b. ISE Logik Industries, Inc; MVRA 900: www.iselogik.com.
   c. Specialty Products Group; Vapor Lock 20/20: www.spggogreen.com.
   d. Substitutions: Not permitted.

2.03 CONCRETE MIX DESIGN

A. General: Comply with requirements of Section 03 3000 - Cast-in-Place Concrete and as follows.

B. Moisture Vapor Reduction Admixture (MVRA):
   1. Where required add admixture as recommended in ACI 211.1 and at rates required by manufacturer.

2.04 REINFORCEMENT MATERIALS

A. Comply with requirements of Section 03 3000 - Cast-in-Place Concrete.

2.05 DENSIFIERS AND HARDENERS

A. Liquid Densifier/Hardener: Penetrating chemical compound that reacts with concrete, filling the pores and dustproofing; for application to concrete after set.
   1. Composition: Sodium silicate.
   2. Products:
      a. Dayton Superior Corporation; Densifier J13: www.daytonsuperior.com.
      b. Euclid Chemical Company; EUCO DIAMOND HARD: www.euclidchemical.com.
      c. Kaufman Products Inc; SureHard: www.kaufmanproducts.net.
      d. L&M Construction Chemicals, Inc, a subsidiary of Laticrete International, Inc; SEAL HARD: www.lmcc.com.
      e. W. R. Meadows, Inc; Liqui-Hard: www.wrmeadows.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.
   3. Locations:
      a. Use at following locations: Unless otherwise indicated, unfinished exposed concrete floors, equipment pads, ramps, steps, and stairs are to be finished using liquid densifier/hardener.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. In addition to requirements of this Section comply with requirements of Section 03 3000 - Cast-in-Place Concrete.

3.02 UNDERSLAB VAPOR RETARDER

A. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
   1. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings.

3.03 MOISTURE VAPOR REDUCTION ADMIXTURE (MVRA)

A. Dispense MVRA according to concrete mix designs.

B. Add MVRA to concrete according to manufacturer's written instructions.

3.04 CONCRETE REQUIREMENTS AT HARD TILE FLOOR FINISHES

A. Hard tile specified in Section 09 3000 - Hard Tiling shall be installed on concrete floor slabs without control joints and slab jointing.

B. Unless more stringent requirements are indicated, provide the following minimum requirements at concrete floor slabs where hard tile finishes shall be installed:

1. Concrete Floor Slab Thickness: 5 inches.
2. Reinforcement: No. 4 reinforcing steel (rebars) at 12 inches on center each way.
   a. Fiber reinforcement is not permitted.

C. Control Joints and Slab Jointing: None permitted.

3.05 FLOOR FLATNESS AND LEVELNESS TOLERANCES

A. General: Unless more stringent requirements are indicated or specified in Section 03 3000 - Cast-in-Place Concrete, comply with floor flatness and levelness values specified in this section.

B. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:

1. Exposed to View and Foot Traffic: F(F) of 25; F(L) of 20, on-grade only.
2. Under Thick-Bed Tile: F(F) of 20; F(L) of 15, on-grade only.
3. Under Carpeting: F(F) of 25; F(L) of 20, on-grade only.
4. Under Thin Resilient Flooring and Thinset Tile: F(F) of 35; F(L) of 25, on-grade only.
5. Under Wood Gymnasium Floors and Stage Floors: F(F) of 50.
   a. Verify that concrete subfloor surface is smooth and flat to plus or minus 1/8 inch in 10 feet.
6. Stained and Polished Concrete Floors: F(F) of 50; F(L) of 30, on-grade only.

C. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155/E1155M (ASTM E1155M), within 48 hours after slab installation; report both composite overall values and local values for each measured section.

D. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.

E. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.06 LIQUID DENSIFIER/HARDENER

A. Apply liquid densifier/hardener in accordance with manufacturer's instructions.

B. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.

C. Verify that water vapor emission from concrete and relative humidity in concrete are within limits established by liquid densifier/hardener manufacturer according to ASTM D4263 and ASTM F2170.

D. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.

3.07 FIELD QUALITY CONTROL

A. Slab Testing: Cooperate with manufacturer of specified moisture vapor reduction admixture (MVRA) to allow access for sampling and testing concrete for compliance with warranty requirements.

END OF SECTION 03 3003

SECTION 04 2000 - UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete block.
B. Clay facing brick.
C. Reinforcement and anchorage.
D. Flashings.
E. Cavity wall insulation.
F. Lintels.
G. Accessories.
H. Products installed under this section:
   1. Precast architectural concrete units set in masonry; furnished by Section 03 4500 - Precast Architectural Concrete.
   2. Cast stone units set in masonry; furnished by Section 04 7200 - Cast Stone Masonry.
   3. Loose steel lintels in unit masonry; furnished by Section 05 5000 - Metal Fabrications.
   4. Manufactured reglets embedded in unit masonry; furnished by Section 07 6200 - Sheet Metal Flashing and Trim.
I. Products furnished under this section:
   1. Dovetail anchor slots for connecting masonry to cast-in-place concrete; installed by Section 03 3000 - Cast-in-Place Concrete.
   2. Structural steel anchor sections for connecting masonry to structural steel; installed by Section 05 1200 - Structural Steel Framing.

1.02 REFERENCE STANDARDS

A. ACI 315 - Guide to Presenting Reinforcing Steel Design Details; 2018.
B. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber; 2020.
C. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2018.
D. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.
E. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
F. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2023a.
G. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
H. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.
I. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2024.
J. ASTM C90 - Standard Specification for Dry-Cast Loadbearing Concrete Masonry Units; 2024a.
K. ASTM C91/C91M - Standard Specification for Masonry Cement; 2023.
L. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.
M. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
N. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale); 2024.
O. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2019a, with Editorial Revision.
P. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2024.

Q. ASTM C476 - Standard Specification for Grout for Masonry; 2023.
R. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2016.
S. ASTM C 1329 - Standard Specification for Mortar Cement - 2016.
T. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry; 2019a.
U. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing; 2025.
V. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing; 2017.
W. BIA Technical Notes No. 13 - Ceramic Glazed Brick Exterior Walls; 2017.
X. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata (2024).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Product Coordination and Limitations: Provide products that when combined with materials and components of other sections, form exterior wall assemblies as detailed on Drawings, that comply with NFPA 285 testing and acceptance criteria.

1.04 SUBMITTALS

A. Product Data: Provide data for the following:
   1. Masonry Units:
      a. Include data on material properties.
      b. Masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Brick units:
      a. For exposed brick, include test report for efflorescence according to ASTM C 67.
      b. Include size-variation data verifying that the actual range of sizes falls within specified tolerances.
   3. Cementitious materials. Include name of manufacturer, brand name and type.
   4. Mortar admixturers.
   5. Preblended, dry mortar mixes. Include description of type and proportion of ingredients.
   6. Grout mixes. Include description of type and proportion of ingredients.
   7. Sound Isolating anchors.
   8. Anchors, ties, weep/cavity vent, preformed control-joint gaskets, cavity drainage material, and metal accessories.
B. Shop Drawings: Indicate pertinent dimensions, materials, anchorage, size and type of fasteners, and accessories for masonry.
   1. Masonry Units: Indicate sizes, profiles, coursing, and locations of special units.
   2. Reinforcing: Indicate bending, lap lengths, and placement of unit masonry reinforcing bars.
      a. Comply with ACI 315.
   3. Flashings: Provide details of embedded flashings including end dams, corners, drips, weeps.
C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C91/C 91M for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirements.
D. Samples: Submit 3 samples of standard block, decorative block, facing brick, ceramic glazed facing brick, and ceramic glazed structural clay facing tile units to illustrate color, texture, and extremes of color range.

E. Test Reports:
   1. Concrete masonry manufacturer's test reports for units with integral water repellent admixture.
   2. Masonry Veneer Anchors: At wall cavities greater than 4-1/2 inches, provide masonry veneer anchor manufacturer's test reports indicating compliance with TMS 402/602 for lateral load requirements; wall cavity depth includes airspace and cavity wall insulation thickness.
F. NFPA 285 Documentation: For each product, submit documentation listing compatible materials and components that when used together in wall assemblies as detailed on Drawings, comply with NFPA 285 testing and acceptance criteria.
G. Manufacturer's Qualification Statement.
H. Installer's Qualification Statement.
I. Cold-Weather and Hot-Weather Procedures: Detail description of methods, material, and equipment to be used to comply with requirements.

1.05 QUALITY ASSURANCE

A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
B. Fire Rated Assemblies: Comply with applicable codes and UL Assembly Numbers indicated.
C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum 5 years of documented experience.
D. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years of documented experience.

1.06 MOCK-UPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for material and execution.
B. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar, accessories, structural backup, wall openings, flashings (with lap joint, corner, and end dam), through-wall flashing (omit masonry above half of flashings, wall insulation, and sealant-filled joint at least 16 inches long in exterior wall in mock-up.
C. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
D. Locate where directed.
E. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
F. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
G. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
   1. Approval of mockups is also for other materials and construction qualities specifically approved by Architect in writing.
   2. Approval of mockups does not constitute approval of deviations from Contract Documents contained in the mock-ups unless Architect specifically approves such deviations in writing.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
B. Store masonry units on elevated platforms in a dry location. If units are not stored in a enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
F. Handle and store ceramic glazed masonry units in protective cartons or trays. Do not remove from protective packaging until ready for installation.

1.08 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 UNIT MASONRY, GENERAL

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

2.02 CONCRETE MASONRY UNITS (CMU)

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depths as indicated on drawings for specific locations.
   2. Special Shapes: Provide non-standard blocks configured for corners, lintels, headers, control joint edges, and other detailed conditions.
   3. Exposed Outside Block Corners: Provide bullnose, radiused, corners unless otherwise indicated on Drawings.
      a. Field-ground radiused corners are not permitted.
      b. Stop bullnose at bulkhead/soffits.
      c. Provide square corners at door frame even with block and bullnose where door frame is set back from corner.
   4. Load-Bearing and Non-Loadbearing Units: ASTM C90, normal weight.
      a. Standard Units:
         1) Exposed Faces: Manufacturer's standard color and texture as approved by Architect per ASTM C90.
         2) Manufacturers:
            (a) Best Block Company: www.bestblock.net.
            (b) Consumers Concrete Corp.: www.consumersconcrete.com.
            (c) Echelon by Oldcastle: www.echelonmasonry.com.
            (d) Fendt Builder’s Supply, Inc.: www.fendtproducts.com.
            (e) Grand Blanc Cement Products: www.grandblanccementproducts.com.
            (f) Michigan Certified Products, Inc.: www.micertconcrete.com.
            (g) National Block Company: www.nationalblock.com.
            (h) Substitutions: See Section 01 6000 - Product Requirements.

2.03 BRICK UNITS

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
   3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
   4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
B. Manufacturers: Provide products from the manufacturer listed for each brick type.
   1. Substitutions: Not permitted.
C. Facing Brick:
   1. Special shapes: Provide molded units as required by conditions indicated, unless standard units can be sawn to produce equivalent effect.
   2. Type A: Field Brick.
      a. Manufacturer: Elgin Butler Brick Company - .
         1) Substitutions: Not permitted.
      b. ASTM C216, Type FBS, Grade SW.
      c. Size (Actual): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long (Modular).
      d. Color/Blend: Colonial Red Glazed.
      e. Texture: Smooth.
   3. Type B: Accent Brick.
      a. Manufacturer: Glen-Gery Corp.: www.glengery.com..
         1) Substitutions: Not permitted.
      b. ASTM C216, Type FBS, Grade SW.

c. Size (Nominal): 3-5/8 inches wide by 2-1/4 inches high by 11-5/8 inches long (Utility).
d. Color/Blend: Woodbury.
e. Texture: Velour.

2.04 MORTAR AND GROUT MATERIALS

A. Masonry Cement: ASTM C91/C91M.
B. Mortar Cement: ASTM C1329.
C. Mortar Aggregate: ASTM C144.
D. Grout Aggregate: ASTM C404.
E. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
1. Color(s): As selected by Architect from manufacturer's full range.
2. Manufacturers:
a. Davis Colors: www.daviscolors.com.
b. Lambert Corporation: www.lambertusa.com.
c. Solomon Colors: www.solomoncolors.com/sle.
d. Substitutions: See Section 01 6000 - Product Requirements.
F. Water: Clean and potable.
G. Packaged Dry Material for Mortar for Unit Masonry:
1. At Contractor's option, prepackaged dry material for mortar may be used subject to compliance with mortar requirements of this section including, but not limited to, the following:
a. Mortar Types: As indicated.
b. Color(s): As selected by Architect from manufacturer's full range.
c. Use only water repellent admixture for mortar from the same manufacturer as water repellent admixture in masonry units.
2. Portland Cement Based: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
a. Manufacturers:
1) Amerimix, an Oldcastle brand; www.amerimix.com.
2) The QUIKRETE Companies; wwwquikcrete.com.
3) SPEC MIX, Inc.: www.specmix.com.
4) Substitutions: See Section 01 6000 - Product Requirements.
3. Masonry Cement Based: Premixed masonry cement and mason's sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
a. Manufacturers:
1) Amerimix, an Oldcastle brand; www.amerimix.com.
2) The QUIKRETE Companies; wwwquikcrete.com.
3) SPEC MIX, Inc.: www.specmix.com.
4) Substitutions: See Section 01 6000 - Product Requirements.
H. Packaged Dry Material for Grout for Masonry: Premixed cementitious materials and dried aggregates; capable of producing grout of the specified strength in accordance with ASTM C476 with the addition of water only.
1. At Contractor's option, prepackaged dry material for grout may be used subject to compliance with grout requirements of this section.
2. Manufacturers:
a. Amerimix, an Oldcastle brand; www.amerimix.com.
b. The QUIKRETE Companies; wwwquikcrete.com.
c. SPEC MIX, Inc.: www.specmix.com.
d. Substitutions: See Section 01 6000 - Product Requirements.

2.05 REINFORCEMENT AND ANCHORAGE

A. Manufacturers:

1. Basis-of-Design Product: The design for each item specified is based on the product named. Provide either the named product or a comparable product by one of the following:
   a. Fero Corp.; www.ferocorp.com.
   b. Heckmann Building Products; www.heckmannbuildingprods.com.
   c. Hohmann & Barnard, Inc.; www.h-b.com.
   d. Wire-Bond; www.wirebond.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.

B. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi), deformed billet bars; uncoated.

C. Reinforcing Bar Positioners: 0.156 inch, ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to 16 CFR 1201 Class B.
   1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: RB and RB-Twin Rebar Positioners.

D. Reinforcing Bar Lap Joint Ties: ASTM A1064/A1064M steel wire, mill galvanized to 16 CFR 1201 Class 3.
   1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: Spyra-Lox Rebar Lap-Joint Tie.

E. Single Wythe Joint Reinforcement: Truss or ladder type; ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to 16 CFR 1201 Class B; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.
   1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: 120 Truss-Mesh or 220 Ladder-Mesh.

F. Adjustable Multiple Wythe Joint Reinforcement: Truss or ladder type with adjustable ties or tabs spaced at 16 in on center ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to ASTM A153/153M, Class B; 0.1483 inch side rods with 0.1483 inch cross rods and adjustable components of 0.1875 inch wire; width of components as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from each masonry face.
   1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: 170 Truss LOX-ALL Adjustable Eye Wire or 270 Ladder LOX-ALL Adjustable Eye Wire with 2X-HOOK.

G. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches; hot dip galvanized to ASTM A153/A153M Class B.
   1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: 344 Rigid Partition Anchor.

H. Partition Top Anchors: 0.1875 inch thick metal plate with a 3/8 inch diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube; hot dip galvanized to ASTM A153/A153M Class B.
   1. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: PTA-420-HS and PTA Tubes.

I. Dovetail Anchor Slots for Connecting to Concrete: 2-piece anchors that permit differential movement between masonry and concrete frame, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face.
   1. Concrete frame: Dovetail anchors of bent steel, nominal 1 inch width by 1 inch deep by 0.03 in thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.
      a. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: 305 Dovetail Slot with 315 Flexible Dovetail Brick Ties.

J. Adjustable Anchors for Connecting to Structural Steel Framing: 2-piece anchors that permit differential movement between masonry and steel frame, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face.

1. Crimped wire anchors for welding to frame, 0.25 inch thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.
2. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: 359/359FP anchors with 301W or VBT ties.

K. Adjustable Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
1. For cold-formed metal framing and sheathing back-up.
2. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners.
3. Wire ties: Rectangular shape, 0.1875 inch thick.
4. Vertical adjustment: Not less than 2 inches.
5. Basis-of-Design Product: Hohmann & Barnard, Inc.; www.h-b.com: HB-213 anchors with 2X-HOOK.

L. Sound Isolating Anchors.
1. Provide as indicated on the Drawings.
a. Basis of Design Product: Provide PSB-M isolators as manufactured by Kinetics. Texture Wire cut or as follows:
1) Mason Industries AB-716.

2.06 FLASHINGS

A. Flexible Fabric Flashing - Self-Adhering: Self-adhering stainless steel/polymer fabric flashing. ASTM A240/A240M; 2 mil type 304 stainless steel sheet bonded on one side to one sheet of polymer fabric. Flashing shall be self-adhering using a pressure-sensitive adhesive.
1. Type 304 stainless steel.
a. Thickness: 2 mils, minimum.
2. Manufacturers:
a. Hohmann & Barnard, Inc; Mighty-Flash Stainless Flashing SA: www.h-b.com/#sle.
b. WIRE-BOND; Bond-N-Flash SA: www.wirebond.com/#sle.
c. York Manufacturing, Inc; Multi-Flash SS: www.yorkmfg.com/#sle.
d. Substitutions: See Section 01 6000 - Product Requirements.

B. Factory-Fabricated Inside and Outside Flashing Corners and End Dams: Stainless steel.
1. Manufacturer shall be the same as flexible fabric flashing manufacturer.

C. Factory-Fabricated Drip Plates including Inside and Outside Corners: Stainless steel.
1. Pre-formed smooth drip plates with hemmed edges.
2. Manufacturer shall be the same as stainless steel/polymer fabric flashing manufacturer.

D. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.
1. Manufacturer shall be the same as flexible fabric flashing manufacturer.

2.07 CAVITY WALL INSULATION

A. Refer to Section 07 2100 Thermal Insulation.

2.08 ACCESSORIES

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints. ASTM D2000, 2AA-805.
1. Manufacturers:
a. Hohmann & Barnard, Inc: www.h-b.com/sle.
b. WIRE-BOND: www.wirebond.com/#sle.
c. Substitutions: See Section 01 6000 - Product Requirements.

B. Compressible Joint Filler: Closed cell neoprene; oversized 50 percent to joint width; self expanding; in maximum lengths available. ASTM D1056, Grade 2A1.
1. Manufacturers:
a. Hohmann & Barnard, Inc: www.h-b.com/sle.

b. WIRE-BOND: www.wirebond.com/#sle.
c. Substitutions: See Section 01 6000 - Product Requirements.

C. Cavity Mortar Control/Drainage Material: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
1. Mortar Diverter: Semi-rigid mesh designed for installation at flashing locations.
a. Full depth of cavity and 10 inches high, with dovetail-shaped notches 7 inches deep that prevent clogging with mortar droppings.
b. Basis-of-Design Product: Provide Hohmann & Barnard, Inc.; www.h-b.com; Mortar Trap or a comparable product by one of the following:
1) Advanced Building Products Inc.; www.advancedbuildingproducts.com.
2) Heckmann Building Products; www.heckmannbuildingprods.com.
3) Mortar Net Solutions; www.mortarnet.com.
4) Wire-Bond; www.wirebond.com.
5) Substitutions: See Section 01 6000 - Product Requirements.

D. Building Paper: ASTM D226/D226M, Type I ("No.15") asphalt felt.

E. Termination Bars: Stainless steel, 1/8 inch thick by 1-1/2 inch high with 3/8 inch sealant flange at top; compatible with flashing membrane and adhesives.
1. Manufacturers:
a. Advanced Building Products Inc.; www.advancedbuildingproducts.com
b. Heckmann Building Products; www.heckmannbuildingprods.com.
c. Hohmann & Barnard, Inc.; www.h-b.com.
d. Wire-Bond; www.wirebond.com.
e. York Manufacturing, Inc.; www.yorkmfg.com
f. Substitutions: See Section 01 6000 - Product Requirements.

F. Weep Inserts and Cavity Vents:
1. Type: Plastic cellular/honeycomb design.
2. Color(s): As selected by Architect from manufacturer's full range.
3. Basis-of-Design Product: Provide Hohmann & Barnard, Inc.; www.h-b.com; QV Quadro-Vent or a comparable product by one of the following:
a. Advanced Building Products Inc.; www.advancedbuildingproducts.com.
b. Heckmann Building Products; www.heckmannbuildingprods.com.
c. Mortar Net Solutions; www.mortarnet.com.
d. Wire-Bond; www.wirebond.com.
e. Substitutions: See Section 01 6000 - Product Requirements.

G. Mortar and Grout Screen: 1/4 inch square, polypropylene monofilament screening for preventing grout flow; width sized to match masonry widths.
1. Basis-of-Design Product: Provide Hohmann & Barnard, Inc.; www.h-b.com; MGS or a comparable product by one of the following:
a. Heckmann Building Products; www.heckmannbuildingprods.com.
b. Wire-Bond; www.wirebond.com.
c. Substitutions: See Section 01 6000 - Product Requirements.

H. Masonry Cleaners:
1. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
a. Basis-of-Design Products: Provide PROSOCO, Inc.; www.prosoco.com: Sure Klean 600 or Sure Klean Vana Trol or a comparable product by one of the following:
1) Diedrich Technologies, Inc.; www.diedrichtechnologies.com.
2) Substitutions: See Section 01 6000 - Product Requirements.

2.09 LINTELS

A. Masonry Lintels: Masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and weight classification; reinforcing bars as indicated, and filled with grout.
B. Loose Steel Lintels: Refer to Section 05 5000 - Metal Fabrications.

2.10 MORTAR AND GROUT MIXING

A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
   1. Masonry below grade and in contact with earth: Type S.
   2. Exterior, loadbearing masonry: Type S.
   3. Exterior, non-loadbearing masonry: Type N.
   4. Interior, loadbearing masonry: Type S.
   5. Interior, non-loadbearing masonry: Type N.
   6. Precast concrete units: Same Type as wall masonry in which unit is set.
   7. Limestone units: Same Type as wall masonry in which unit is set.
   8. Pointing Mortar: Type N.
B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.
C. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
   1. Grout Strength: 3000 psi at 28 days, unless otherwise indicated.
D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.01 SALVAGING BRICK

A. General: Comply with Section 02 4100 - Demolition.
B. Where indicated, remove and salvage existing brick.
   1. Carefully remove brick by hand. Cut out full units from joint to joint.
      a. If required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.
   2. Salvage as many whole, undamaged bricks as needed for new construction.
   3. Salvage damaged brick that may be cut and used where cut units are required.
   4. Take care not to chip, crack or otherwise damage surrounding masonry.
C. Remove mortar, loose particles and soil from salvaged brick by cleaning with hand chisels, brushes and water. Store brick for reuse.
D. Clean remaining masonry at edges of removal areas by removing mortar, dust, and loose debris in preparation for new construction.
E. Support and protect remaining masonry that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.

3.02 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.
B. Verify that foundations are within tolerances specified.
C. Verify that related items provided under other sections are properly sized and located.
D. Verify that built-in items are in proper location, and ready for roughing into masonry work.
E. Verify that reinforcing dowels are properly placed.

3.03 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.

3.04 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

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

3.05 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.
B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
C. Existing Masonry: Match coursing and bonding of existing masonry unless otherwise indicated.
D. Concrete Masonry Units: Unless otherwise indicated:
    1. Bond: Running.
    2. Coursing: One unit and one mortar joint to equal 8 inches.
    3. Mortar Joints: Concave.
    4. Mortar Joint Thickness: 3/8 inch.
E. Brick Units: Unless otherwise indicated:
    1. Bond: Running.
    2. Coursing: Three units and three mortar joints to equal 8 inches.
    3. Mortar Joints: Concave.
    4. Mortar Joint Thickness: 3/8 inch.

3.06 PLACING AND BONDING

A. Lay hollow masonry units with face shell bedding on head and bed joints.
B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
C. Remove excess mortar and mortar smears as work progresses.
D. Interlock intersections and external corners.
E. Tooth-in new masonry work with existing, unless otherwise indicated on Drawings.
F. Tooth-in cutting and patching masonry work unless otherwise indicated on Drawings.
G. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
H. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
I. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.
J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.
K. Isolate cast stone units and precast architectural concrete units from clay masonry with building paper or similar method of providing a continuous bond break/slip plane.
L. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
    1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
    2. Allow cleaned surfaces to dry before setting.
    3. Wet joint surfaces thoroughly before applying mortar.
    4. Rake out mortar joints for pointing with sealant.

3.07 WEEPS INSERTS/CAVITY VENTS

A. Install weep inserts in veneer and cavity walls at 24 inches on center horizontally above through-wall flashing, above shelf angles and lintels, and at bottom of walls.

B. Install cavity vents in veneer and cavity walls at 24 inches on center horizontally below shelf angles and lintels and near top of walls.

3.08 CAVITY MORTAR CONTROL

A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.

B. Provide not less than 2 inches of airspace between back of masonry veneer and face of insulation.

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

C. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.

D. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.09 HORIZONTAL JOINT REINFORCEMENT AND ANCHORAGE - SINGLE WYTHE MASONRY AND CAVITY WALL MASONRY

A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Lap joint reinforcement ends minimum 6 inches.

E. Masonry to Structural Steel and Concrete:

1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 24 inches horizontally and 24 inches vertically.

F. Embed ties and anchors in mortar joint and extend into masonry unit a minimum of 1-1/2 inches with at least 5/8 inch mortar cover to the outside face of the anchor.

3.10 MASONRY VENEER REINFORCEMENT AND ANCHORAGE

A. Masonry Back-Up: Embed anchors to bond veneer at maximum 16 inches on center vertically and 16 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

B. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 16 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

C. Embed ties and anchors in mortar joint and extend into masonry veneer unit a minimum of 1-1/2 inches with at least 5/8 inch mortar cover to the outside face of the anchor.

3.11 MASONRY FLASHINGS

A. General:

1. Install masonry flashings according to manufacturer's instructions and as indicated on the Drawings.
2. Remove or cover protrusions or sharp edges that could puncture flashings.
3. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

4. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
   a. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up at least 8 inches, minimum, to form watertight pan at non-masonry construction.
5. Terminate flashing up 8 inches minimum on vertical surface of backing:
   a. Install vertical leg of flashing over fluid-applied or self-adhered air/vapor barriers over backing or per manufacturer’s direction, unless otherwise indicted.
   b. Anchor vertical leg of flashing into backing with a termination bar and sealant.
6. Install flashing in accordance with manufacturer's instructions and BIA Technical Notes No. 7, unless more stringent requirements are specified in this section.

B. Flexible Fabric Flashing:
1. Use factory-fabricated drip plates, corners and end dams.
2. Extend flexible fabric flashing to within 1/4 inch of exterior face of masonry overlapping metal drip plate.
3. Extend flexible fabric flashing full width of cavity space and turn up inner masonry wythe or sheathing at least 14 inches.
4. Secure flexible fabric flashing to wall with continuous termination bar and apply sealant across top of termination bar.

3.12 LINTELS

A. Install loose steel lintels over openings.
B. Install reinforced unit masonry lintels over openings where steel lintels are not scheduled.
1. Unless otherwise indicated, reinforce as follows:
   a. Openings to 48 inches: Place two, No. 4 reinforcing bars 1 inch from bottom web.
   b. Openings from 48 inches to 80 inches: Place two, No. 5 reinforcing bars 1 inch from bottom web.
   c. Openings over 80 inches: Reinforce openings as detailed.
2. Do not splice reinforcing bars.
3. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
4. Place and consolidate grout fill without displacing reinforcing.
5. Allow masonry lintels to attain specified strength before removing temporary supports.

C. Where the Drawings do not indicate otherwise, provide reinforced unit masonry lintels at all openings and penetrations wider than 12 inches in brick and 24 inches in CMU.
D. Maintain minimum 8 inch bearing on each side of opening unless otherwise indicated.

3.13 BOND BEAMS

A. Bond Beams: At bond beams or other locations for horizontally reinforced masonry, provide special masonry units.
B. Reinforce bond beams with 2, No. 5 bars, 1 inch from bottom web unless otherwise indicated.
C. Lap reinforcing bar splices minimum 24 bar diameters, unless otherwise indicated.
D. Place and consolidate grout fill without displacing reinforcing.

3.14 VERTICAL MASONRY REINFORCEMENT

A. Reinforcement: Size and place vertical masonry reinforcement to comply with TMS 402/602 requirements and as indicated on Drawings.
B. Place and consolidate grout fill without displacing reinforcing.

3.15 GROUTING

A. Reinforced Hollow Unit Masonry: Keep vertical cores to be grouted clear of mortar, including bed area of first course.
B. Perform grouting by means of high-lift technique, except in locations that mandate use of low-lift grouting technique.
1. Do not use high-lift grouting where size of cavities mandates use of fine grout.

C. Low-Lift Grouting:

1. Limit height of pours to 12 inches.
2. Limit height of masonry to 16 inches above each pour.
3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.

D. High-Lift Grouting:
1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
2. Clean out masonry cells and other cavities to be grouted by high pressure water spray or compressed air. Remove debris, allow to dry, and inspect before sealing cleanout openings.
3. Hollow Masonry: Limit lifts to maximum 4 feet and pours to maximum height of 24 feet.
4. Place grout for spanning elements in single, continuous pour.

3.16 GROUTED COMPONENTS

A. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
B. Place and consolidate grout fill without displacing reinforcing.
C. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.17 CONTROL AND EXPANSION JOINTS

A. Do not continue horizontal joint reinforcement through control or expansion joints.
B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
1. Refer to Section 07 9200 - Joint Sealants for sealant installation.

3.18 BUILT-IN WORK

A. As work progresses, install built-in metal door frames, glazed frames, anchor bolts, plates, and reglets and other items to be built into the work and furnished under other sections.
B. Install built-in items plumb, level, and true to line.
C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.

3.19 TOLERANCES

A. Dimensions and Locations of Elements:
1. Location of elements in plan; do not vary from that indicated on Drawings by more than:
a. Plus or minus 1/2 inch.
2. Dimensions in cross section; do not vary from that indicated on Drawings by more than:
a. Minus 1/4 inch.
b. Plus 1/2 inch.

B. Maximum Variation from Alignment of Columns and Pilasters: 1/4 inch.
C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.
H. Lines and Levels:
1. Maximum variation from level:
a. Includes, but is not limited to, the following:
1) Lintels.
2) Sills.

3) Parapets.
4) Reveals.
5) Other conspicuous lines.

b. Do not vary from level by more than:
1) 1/4 inch in 20 feet.
2) 1/2 in in 40 feet or more.

2. Maximum variation from plumb:
a. Includes, but is not limited to, the following:
1) External corners.
2) Control and expansion joints.
3) Reveals.
4) Other conspicuous lines.

b. Do not vary from plumb by more than:
1) 1/4 inch in 20 feet.
2) 1/2 in in 40 feet or more.

I. Mortar Joint Thickness: Do not vary thickness indicated by more than plus or minus 1/8 inch.

3.20 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 4000 - Quality Requirements.

3.21 CLEANING

A. Protect surrounding elements and finishes from damage due to cleaning procedures.
B. Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 10 feet away, subject to Architect's approval.
C. Remove excess mortar and mortar droppings.
D. Clean soiled surfaces with cleaning solution.
E. Apply masonry cleaners to masonry surfaces according to manufacturer's written instructions; use brush or spray application.
1. Periodically during rinsing, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
a. Repeat rinsing until tested pH of water runoff is between 6.7 and 7.5.
F. Ground-Face CMU: Refer to Section 07 1900-Water Repellent Acrylic Penetrating Sealer for field applied sealer.

END OF SECTION 04 2000

SECTION 05 1200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Structural steel.
   2. Grout.

1.02 DEFINITIONS

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

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components.

C. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and fabricator.

B. Welding certificates.

C. Mill test reports for structural steel, including chemical and physical properties.

D. Source quality-control reports.

E. Field quality-control and special inspection reports.

1.06 QUALITY ASSURANCE

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

B. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303.
   2. AISC 360.
   3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and relubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.
   1. Select and complete connections using schematic details indicated and AISC 360.

B. Moment Connections: Fully restrained.

C. Construction: Combined system of moment frame, braced frame, and shear walls.

2.02 STRUCTURAL-STEEL MATERIALS

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

B. Channels, Angles-Shapes: ASTM A 36/A 36M.

C. Plate and Bar: ASTM A 36/A 36M.

D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade C, structural tubing.

E. Welding Electrodes: Comply with AWS requirements.

2.03 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
   1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Plain.

C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

D. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.
   1. Finish: Plain.

E. Threaded Rods: ASTM A 36/A 36M.
   1. Finish: Plain.

F. Steel Rod Bracing System: Stainless steel rod system. Basis of design is Halfen DETAN Rod System. Alternate suppliers/systems may be submitted for owner approval.
   1. Tension Rods
      a. Material: Stainless steel, A4, Type 316 with 51,500 psi yield strength. [ASTM A666]

b. Finish: Electropolished or Hand polished.
c. Diameter: As required for design loads.

2. Couplers: 5-1/2 inches
   a. Material: Stainless steel with 235 MPa (34,000 psi) minimum yield strength [ASTM A666]
3. Anchor Discs:
   a. Material: Stainless steel A4 with 235 MPa (34,000 psi) minimum yield strength [ASTM A666]
4. Connecting Plates:
   a. Material: Stainless steel, Type 316 with 205 MPa (30,000 psi) minimum yield strength, ASTM A666. Finned for welding to steelwork

2.04 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.05 GROUT

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

2.06 FABRICATION

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

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

2.07 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.08 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

   1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
   2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

2.09 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

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

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

3.03 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
   3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.04 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Verify structural-steel materials and inspect steel frame joint details.
   2. Verify weld materials and inspect welds.
   3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
   1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
      a. Liquid Penetrant Inspection: ASTM E 165.
      b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
      c. Ultrasonic Inspection: ASTM E 164.
      d. Radiographic Inspection: ASTM E 94.

END OF SECTION

SECTION 05 3100 –STEEL DECKING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Roof deck.
   2. Acoustical roof deck.
   3. Composite floor deck.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:
   1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.03 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Evaluation reports.

D. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

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

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

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

2.02 ROOF DECK

A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 50, G60 zinc coating.
2. Deck Profile: As indicated, Type WR, wide rib.
3. Profile Depth: 1-1/2 inches.
4. Design Uncoated-Steel Thickness: 0.0358 inch.

2.03 ACOUSTICAL ROOF DECK

A. Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
   1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 40, G60 zinc coating.
   2. Deck Profile: As indicated.
   3. Profile Depth: 2 inches.
   4. Design Uncoated-Steel Thickness: 0.0358 inch.
   5. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber
      a. Factory install sound-absorbing insulation into cells of cellular deck.

2.04 COMPOSITE FLOOR DECK

A. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with SDI C, with the minimum section properties indicated, and with the following:
   1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 50, G60 zinc coating.
   2. Deck Profile: As indicated.
   3. Profile Depth: 2 inches.
   4. Design Uncoated-Steel Thickness: 0.0358 inch.

2.05 ACCESSORIES

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

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

G. F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile indicated.

H. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

I. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

J. Galvanizing Repair Paint: ASTM A 780/A 780M SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

K. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

C. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

D. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

E. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

F. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

G. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

H. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
   1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.

I. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

J. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

K. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.02 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
   1. Field welds will be subject to inspection.

B. Steel decking will be considered defective if it does not pass tests and inspections.

C. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
   1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors that are already tested.

D. Prepare test and inspection reports.

3.03 PROTECTION

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

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

END OF SECTION

SECTION 05 4000 - COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Load-bearing formed steel stud exterior wall and interior wall framing.

1.02 RELATED REQUIREMENTS

A. Section 09 2216 - Non-Structural Metal Framing.

1.03 REFERENCE STANDARDS

A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2012.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

D. ASTM C955 - Standard Specification for Cold-Formed Steel Structural Framing Members; 2018, with Editorial Revision.

E. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020 (Reapproved 2024).

F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

G. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on standard framing members; describe materials and finish, product criteria, and limitations.

C. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.

1. Indicate stud layout.
2. Describe method for securing studs to tracks and for bolted and welded framing connections.
3. Design data:
    a. Shop drawings signed and sealed by a professional structural engineer.

D. Designer's Qualification Statement.

E. Manufacturer's Qualification Statement.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum 5 years of documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Framing:

1. ClarkDietrich Building Systems: www.clarkdietrich.com.
2. Jaimes Industries: www.jaimesind.com/#sle.
3. MarinoWARE: www.marinoware.com.
4. MBA Building Supplies, Inc.: www.mbastuds.com.
5. State Building Products; www.statebp.com
6. Steel Stud Solutions, LLC; www.steelstudsolutions.com
7. The Steel Network, Inc: www.SteelNetwork.com.

8. Telling Industries; www.buildstrong.com.
9. Substitutions: See Section 01 6000 - Product Requirements.

B. Framing Connectors and Accessories:
1. Same manufacturer as metal framing.

2.02 FRAMING SYSTEM

A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.

B. Design Requirements: Provide completed framing system having the following characteristics:
1. Design: Calculate structural characteristics of cold-formed steel framing members according to AISI S100-12.
2. Structural Performance: Design, engineer, fabricate, and erect to withstand specified design loads for project conditions within required limits.
3. Design Loads: As indicated on the drawings.
4. Live load deflection meeting the following, unless otherwise indicated:
a. Floors: Maximum vertical deflection under live load of 1/480 of span.
b. Roofs: Maximum vertical deflection under live load of 1/360 of span.
c. Exterior Walls:
1) Maximum horizontal deflection under wind load of 1/720 of span for walls with masonry veneer.
2) Maximum horizontal deflection under wind load of 1/360 of span for all walls without masonry veneer.
d. Interior Walls:
1) Maximum horizontal deflection under a horizontal load of 5 psf shall be 1/720 of span for walls with masonry veneer.
2) Maximum horizontal deflection under a horizontal load of 5 psf shall be 1/240 of span for all walls without masonry veneer.
e. Design non-axial loadbearing framing to accommodate not less than 1/2 in vertical deflection.
5. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
6. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

2.03 FRAMING MATERIALS

A. Studs and Track: ASTM C955; studs formed to channel, C- or Sigma-shaped with punched web; U-shaped track in matching nominal width and compatible height.
1. Gage: Not less than 18 gage, 0.0478 inch.
2. Depth: As indicated.
3. Flange Width: 2 inches.
4. Galvanized in accordance with ASTM A653/A653M, G90/Z275 coating.

B. Framing Connectors: Factory-made, formed steel sheet.
1. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
2. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, shouldered screws or screws and anti-friction or stepped bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.
a. Where continuous studs bypass elevated floor slab, connect stud to slab in manner allowing vertical and horizontal movement of slab without affecting studs; allow for minimum movement of 1/2 inch.
b. Where top of stud wall terminates below structural floor or roof, connect studs to structure in manner allowing vertical movement of slab without affecting studs; allow for minimum movement of 1/2 inch.

3. Fixed Connections: Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.
4. Wall Stud Bridging Connections: Provide mechanical load-transferring devices that accommodate wind load torsion and weak axis buckling induced by axial compression loads. Provide bridging connections as indicated in the shop drawings.

C. Slotted Deflection Track: Head-of-wall slotted vertical deflection track.
1. Basis-of-Design Product: ClarkDietrich Building Systems; MaxTrak Slotted Deflection Track: www.clarkdietrich.com.

D. Fire Stop Slotted Deflection Track: Head-of-wall slotted vertical deflection track with intumescent firestopping strips on each leg.
1. Basis-of-Design Product: ClarkDietrich Building Systems; Blazeframe Fire Stop Deflection Track: www.clarkdietrich.com.

2.04 FASTENERS

A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.
B. Anchorage Devices: Powder actuated and Drilled expansion bolts.
C. Welding: Comply with AWS D1.1/D1.1M.

2.05 ACCESSORIES

A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
B. Sill Plate Gaskets: Closed-cell neoprene foam.
1. Thickness: 1/4 inch.
2. Width: To match width of bottom track.

C. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20 Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION OF STUDS

A. Install components in accordance with manufacturers' instructions and ASTM C1007 requirements.
B. Align floor and ceiling tracks; locate to wall layout. Secure in place by welding or with fasteners at maximum 24 inches on center. Coordinate installation of sealant with floor and ceiling tracks.
C. Install sill plate gaskets continuously under bottom tracks.
D. Place studs at 16 inches on center; not more than 2 inches from abutting walls and at each side of openings. Connect studs to tracks using fastener method.
1. Secure studs to top and bottom runner tracks at both inside and outside flanges.

E. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
F. Install load-bearing studs full length in one piece. Splicing of studs is not permitted.
G. Install load-bearing studs, brace, and reinforce to develop full strength and achieve design requirements.
H. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
I. Install intermediate studs above and below openings to align with wall stud spacing.
J. Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.
K. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
L. Touch-up field welds and damaged galvanized surfaces with primer.

3.03 TOLERANCES

A. Maximum Variation from True Position: 1/4 inch.

B. Maximum Variation of any Member from Plane: 1/8 inch.

END OF SECTION 05 4000

SECTION 05 5000 - METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Shop fabricated steel items, including:
   1. Loose steel lintels.
   2. Bent metal restraints at top of interior masonry walls.
   3. Steel framing supports for the following:
      a. Roof openings.
      b. Folding panel partitions (operable partitions).
      c. Mechanical and electrical equipment.
      d. Applications where framing and supports are not specified in other Sections.
      e. Other items as indicated on Drawings.
   4. Elevator pit ladder.
   5. Elevator hoist beam.
   6. Bollards.
   7. Other items as indicated on Drawings.

B. Slotted channel framing.

1.02 REFERENCE STANDARDS

A. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 2008 (Reaffirmed 2018).

B. ASME A17.1 - Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices; 2022.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

D. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements; 2008 (Reaffirmed 2018).

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

H. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.

I. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.

J. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

K. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.

L. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.

M. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

N. NAAMM MBG 531 - Metal Bar Grating Manual; 2017.

O. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.

P. SSPC-SP 2 - Hand Tool Cleaning; 2024.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
2. Design data: Submit drawings and supporting calculations, signed and sealed by a qualified professional structural engineer.

C. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.
D. Designer's Qualification Statement.
E. Fabricator's Qulaification Statement.

1.04 QUALITY ASSURANCE

A. Design metal fabrications under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
B. Fabricator: Company specializing in performing the work of this section with minimum 5years of documented experience.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Steel Sections: ASTM A36/A36M.
B. Steel Tubing: ASTM A500/A500M, Grade B, cold-formed or ASTM A501/A501M hot-formed structural tubing.
C. Plates: ASTM A283/A283M.
D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black and hot-dip galvanized finish, as indicated.
E. Slotted Channel Framing:
   1. Slotted Channel Framing: ASTM A653/A653M Grade 33.
      a. Channel Size: 1-5/8 by 1-5/8 inches.
      b. Thickness: 0.060 inch (16 gage), minimum.
      c. Finish: Galvanized, G90 coating.
   2. Fittings and Fasteners: Manufacturer's standard fittings and fasteners; finished to match slotted channel framing.
F. Bolts, Nuts, and Washers: ASTM A307, Grade A, galvanized to ASTM A153/A153M where connecting galvanized components.
G. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
I. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, complying with VOC limitations of authorities having jurisdiction.
J. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.02 FABRICATION - GENERAL

A. Fit and shop assemble items in largest practical sections, for delivery to site.
B. Fabricate items with joints tightly fitted and secured.
C. Continuously seal joined members by continuous welds.
D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 LOOSE STEEL LINTELS

A. General:
   1. Fabricate loose steel lintels from steel angles, plates, and other shapes as indicated.
      a. Weld adjoining members together to form a single unit.
   2. Size loose steel lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.
   3. Galvanize loose steel lintels located in exterior walls.
   4. Prime loose steel lintels located in interior walls.
   5. Provide lintels at openings for all equipment and ductwork.

B. See Structural Drawings and/or Specifications for masonry and loose steel lintel schedules.

2.04 BENT METAL RESTRAINTS

A. Bent Metal Restraints: Bent metal restraints that restrain top of interior masonry walls.
   1. Fabricate bent metal restraints from 12 gage, 0.108 inch, thick galvanized sheet steel.
      a. L-shaped: 4 inches wide; each leg 4 inches long. Minimum.
   2. Finish: Prime painted.
   3. Fasteners: As appropriate for indicated substrates.

2.05 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.

C. Finish: Prime painted unless otherwise indicated or at an exterior location.

D. Fabricate support for suspended toilet partitions as follows:
   1. Beams: Continuous steel shapes of size required to limit deflection to L/360 between hangers, but use not less than C8x11.5 channels or another shape with equivalent structural properties.
   2. Hangers: Steel rods, 1/2 inch in diameter, spaced not more than 36 inches o.c.
      a. Thread rods to receive anchor and stop nuts.
      b. Fit hangers with wedge shape washers for full bearing on sloping flanges of support beam.
   3. Braces and Angles: Steel angles of size required to rigidly brace and support beams.

E. Roof Openings: Unless otherwise indicated, provide steel support framing for roof openings as follows:.
   1. Provide steel support framing around entire perimeter of roof opening; span support framing between primary framing or purlins.
   2. Size steel framing not less than the following for spans indicated:
      a. Up to 5 feet: C4x5.4 or L4x4x1/4.
      b. 5 to 7 feet: C5x6.7 or L5x3-1/2x1/4 (LLV).
      c. 7 to 10 feet: C6x8.2 or L6x3-1/2x5/16 (LLV).
      d. Refer to Drawings for conditions other than those listed above.
   3. Limit deflection to L/240.

2.06 LADDERS

A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; prime paint finish, except galvanized at exterior locations and elsewhere as indicated.
   1. Elevator pit ladders: Comply with ASME A17.1.
   2. Side Rails: 3/8 x 2 inches members spaced at 18 inches, unless otherwise indicated.
   3. Rungs: 1 inch diameter solid round bar spaced 12 inches on center, unless otherwise indicated. Slip-resistant surface, Grade 2 - Medium.
      a. Space rungs 7 inches from wall surface, unless otherwise indicated.
      b. Basis-of-Design Product: Provide SlipNOT, Division of W.S. Molnar Company; SlipNOT Ladder Rung: www.slipnot.com, or a comparable product by one of the following:

1) Brown- Campbell Corp.: www.brown-campbell.com.
2) Substitutions: See Section 01 6000 - Product Requirements.

c. Where galvanized finish is required, rungs shall be galvanized by rung manufacturer.

4. Support brackets: At top and bottom of ladder, and not more than 60 inches on center.
5. Landings and Crossovers: Provide steel bar grating platforms supported by steel angles with railings.
   a. Grating: NAAMM MBG 531, welded type.
      1) Top Surface: Non-slip, Grade 2 - Medium.
         (a) Basis-of-Design Product: Provide SlipNOT, Division of W.S. Molnar Company; SlipNOT Grip Grate: www.slipnot.com, or a comparable product by one of the following:
            (1) Substitutions: See Section 01 6000 - Product Requirements.
      2) Fabricate to accommodate design loads.
      3) Limit openings to no more than 1/2 inch in least dimension.
      4) Where galvanized finish is required, grating shall be galvanized by grating manufacturer.

2.07 BOLLARDS

A. Bollards:
   1. Standard Fixed Bollards: Steel pipe, concrete filled, crowned cap, as detailed; galvanized finish.
      a. Steel Pipe: Schedule 40 steel pipe.
      b. Concrete Fill: Refer to Section 03 3000 - Cast-in-Place Concrete.
   2. Surface Mounted Bollards: Steel pipe with minimum 3/8 inch thick steel baseplate welded to bollard base for bolting to concrete slab. Drill baseplates at each corner for 3/4 inch anchor bolts. Galvanized finish.
      a. Steel Pipe: Schedule 40 steel pipe.
      b. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.
   3. Covers: High-density polyethylene thermoplastic (HDPE) sleeves with rounded domed top.
      a. Wall Thickness: 1/4 inch.
      b. Color: As selected by Architect from manufacturer’s standard colors.
      c. Provide complete with manufacturer's standard adhesive tape for securing sleeve to bollard.
      d. Provide covers for all bollards.
      e. Basis-of-Design Product: Provide Ideal Shield; 1/4" Bollard Cover: www.idealshield.com, or a comparable product by one of the following:
         1) Substitutions: See Section 01 6000 - Product Requirements.

2.08 ELEVATOR HOISTWAY BEAMS

A. Elevator Hoistway Beams: Beam sections; prime paint finish. Size as indicated.

2.09 MISCELLANEOUS

A. Protective Coating: Zinc molybdate alkyd.
B. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.10 FINISHES - STEEL

A. Prepare surfaces to be primed in accordance with SSPC-SP2.
B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
C. Prime Painting: One coat.
   1. Provide at all fabrications except at galvanized locations and where otherwise indicated.
D. Where indicated, galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating.
   1. Locations: All exterior locations and elsewhere as indicated.

E. Where indicated, galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating.
   1. Locations: All exterior locations and elsewhere as indicated.

2.11 FABRICATION TOLERANCES

A. Squareness: 1/8 inch maximum difference in diagonal measurements.
B. Maximum Offset Between Faces: 1/16 inch.
C. Maximum Misalignment of Adjacent Members: 1/16 inch.
D. Maximum Bow: 1/8 inch in 48 inches.
E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.
B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION - GENERAL

A. Install items plumb and level, accurately fitted, free from distortion or defects.
B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
C. Field weld components as indicated on shop drawings.
D. Perform field welding in accordance with AWS D1.1/D1.1M.
E. Obtain approval prior to site cutting or making adjustments not scheduled.
F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 BENT METAL RESTRAINTS

A. Space restraints 24 inches on center at top of masonry walls, staggered each side of wall.
B. Secure restraints to substrates with appropriate anchors.

3.05 MISCELLANEOUS FRAMING AND SUPPORTS

A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.06 BOLLARDS

A. Standard Fixed Bollards:
   1. Anchor bollards in place with concrete footings.
      a. Center and align bollards in holes 3 inches above bottom of excavation.
      b. Place concrete and vibrate or tamp for consolidation.
      c. Support and brace bollards in position until concrete has cured.
      d. Hold top of concrete 8 inches below finish grade, unless otherwise indicated.
   2. Fill bollards solidly with concrete, mounding top surface to shed water.
   3. Refer to Section 03 3000 “Cast-in-place Concrete” for concrete.
B. Surface Mounted Bollards:
   1. Anchor bollard baseplate to existing construction with expansion anchors. Provide four anchors per baseplate, unless otherwise indicated.
C. Install sleeve covers according to manufacturer’s written instructions.

3.07 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
B. Maximum Offset From True Alignment: 1/4 inch.
C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 05 5000

SECTION 06 1000 - ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nonstructural dimension lumber framing.
B. Sheathing.
C. Preservative treated wood materials.
D. Fire retardant treated wood materials.
E. Miscellaneous framing and sheathing.
F. Communications and electrical room mounting boards.
G. Concealed wood blocking, nailers, and supports.
H. Miscellaneous wood nailers, furring, and grounds.

1.02 REFERENCE STANDARDS

A. AWC (WFCM) - Wood Frame Construction Manual for One- and Two-Family Dwellings; 2024, with Errata.
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
C. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing; 2003 (Reapproved 2017).
D. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2010 (Reapproved 2024).
E. ASTM D3498 - Standard Specification for Adhesives for Field-Gluing Wood Structural Panels (Plywood or Oriented Strand Board) to Wood Based Floor System Framing; 2019a.
F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
G. AWPA U1 - Use Category System: User Specification for Treated Wood; 2024.
H. PS 1 - Structural Plywood; 2023.
I. PS 20 - American Softwood Lumber Standard; 2025.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.
C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.
C. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
    1. Species: Unless otherwise indicated, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
    2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

1.05 DIMENSION LUMBER

A. Sizes: Nominal sizes as indicated on drawings, S4S.
B. Moisture Content: Kiln-dry or MC15.

C. Stud Framing (2 by 2 through 2 by 6):
   1. Species: Southern Pine.
   2. Grade: No. 2.
D. Stud Framing Framing (2 by 6 through 4 by 16):
   1. Species: Southern Pine.
   2. Grade: No. 2.
E. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
   1. Lumber: S4S, No. 2 or Standard Grade.
   2. Boards: Grade No. 2.

1.06 CONSTRUCTION PANELS

A. Wall Sheathing: Plywood, PS 1, Grade C-C, Exterior Exposure.
   1. Panel Grade: APA Rated; Structural I Sheathing.
   2. Span Rating: 48/24.
   3. Bond Classification: Exterior.
   4. Performance Category: 3/4.
   5. Thickness: 3/4 inch unless otherwise indicated.
   6. Tongue-and-groove edges.
B. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
C. Other Applications:
   1. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
   2. Concealed Plywood in Other Locations: PS 1, C-D Plugged or better.

1.07 ACCESSORIES

A. Fasteners and Anchors:
   1. Metal and Finish: Stainless steel for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
   2. Drywall Screws: Bugle head, hardened steel, power driven type, length three times thickness of sheathing.
   3. Anchors:
      a. Toggle bolt type for anchorage to hollow masonry.
      b. Expansion shield and lag bolt type for anchorage to solid masonry or concrete.
      c. Bolt or ballistic fastener for anchorages to steel
B. Joist Hangers: Hot dipped galvanized steel, sized to suit framing conditions.
   1. For contact with preservative treated wood in exposed locations, provide minimum G185 galvanizing complying with ASTM A653/A653M.
   2. Manufacturers:
      a. MiTek Industries, Inc.: www.mitek-us.com.
      b. Nu-Vue Industries, Inc.: www.nu-vueindustries.com.
      c. Simpson Strong-Tie Company Inc.: www.strongtie.com.
      d. Substitutions: See Section 01 6000 - Product Requirements.
C. Construction Adhesives: Adhesives complying with ASTM C557 or ASTM D3498.
   1. Manufacturers:
      a. Franklin International, Inc; Titebond GREENchoice Heavy Duty Construction Adhesive: www.titebond.com.
      b. Liquid Nails, a brand of PPG Industries, Inc.; LN-903 Heavy Duty Construction Adhesive (Low VOC): www.liquidnails.com.
      c. Substitutions: See Section 01 6000 - Product Requirements.

1.08 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Fire Retardant Treatment:
1. Manufacturers:
   a. Lonza Group: www.wolmanizedwood.com.
   b. Hoover Treated Wood Products, Inc: www.frtw.com.
   c. Koppers, Inc: www.koppersperformancechemicals.com.
   d. Viance, LLC: www.treatedwood.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.
2. Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
   a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
   b. Treat lumber in locations as indicated
3. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
   a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
   b. Interior rough carpentry items are to be fire retardant treated.

C. Preservative Treatment:
1. Manufacturers:
   a. Lonza Group: www.wolmanizedwood.com.
   b. Hoover Treated Wood Products, Inc: www.frtw.com.
   c. Koppers Performance Chemicals, Inc: www.koppersperformancechemicals.com.
   d. Viance, LLC: www.treatedwood.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.
2. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
   a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
   b. Treat lumber exposed to weather.
   c. Treat lumber in contact with roofing, flashing, or waterproofing.
      1) At Contractor's option, roof nailers may be non-preservative treated.
   d. Treat lumber in contact with masonry or concrete.
   e. Treat lumber less than 18 inches above grade.
   f. Treat lumber in other locations as indicated.
3. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
   a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
   b. Treat plywood in contact with roofing, flashing, or waterproofing.
   c. Treat plywood in contact with masonry or concrete.
   d. Treat plywood less than 18 inches above grade.
   e. Treat plywood in other locations as indicated.
4. Preservative Pressure Treatment of Lumber in Contact with Soil: AWPA U1, Use Category UC4A, Commodity Specification A using waterborne preservative.
5. Preservative for Field Application to Cut Surfaces: As recommended by manufacturer of factory treatment chemicals for brush-application in the field.

PART 3 EXECUTION

2.01 PREPARATION

A. Install sill gasket under sill plate of framed walls bearing on foundations; puncture gasket cleanly to fit tightly around protruding anchor bolts.

2.02 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.
B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

2.03 FRAMING INSTALLATION

A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
C. Install structural members full length without splices.
D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AWC (WFCM) Wood Frame Construction Manual.
E. Install horizontal spanning members with crown edge up and not less than 3 inches of bearing at each end.
F. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.
G. Provide bridging at framing in excess of 8 feet span at mid-span and as detailed. Fit solid blocking at ends of members.
H. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

2.04 MISCELLANEOUS FRAMING

A. Install miscellaneous framing level, plumb, and true to line.
B. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AWC (WFCM) Wood Frame Construction Manual.
C. Install horizontal spanning members with crown edge up and not less than 3 inches of bearing at each end.

2.05 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
B. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
C. Provide the following specific nonstructural framing and blocking:
    1. Cabinets and shelf supports.
    2. Wall brackets.
    3. Handrails.
    4. Grab bars.
    5. Towel and bath accessories.
    6. Other locations as indicated.

2.06 INSTALLATION OF CONSTRUCTION PANELS

A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using screws.

B. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.

1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
3. Install adjacent boards without gaps.
4. Size and Location: As indicated on drawings.

2.07 SITE APPLIED WOOD TREATMENT

A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.

B. Allow preservative to dry prior to erecting members.

2.08 TOLERANCES

A. Framing Members: 1/4 inch from true position, maximum.

B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

2.09 CLEANING

A. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.

B. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 1000

SECTION 06 4023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cabinets and millwork - specially fabricated.
   1. Plastic-laminate clad cabinets and millwork.
B. Countertops.- Specified In 12 3600 Countertops
C. Fabric wrapped tackable panels.
D. Miscellaneous items including:
   1. Closet and utility shelving.
   2. Other items as indicated on Drawings.

1.02 REFERENCE STANDARDS

A. ANSI A208.1 - American National Standard for Particleboard; 2022.
B. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
E. AWPA U1 - Use Category System: User Specification for Treated Wood; 2024.
F. BHMA A156.18 - Standard for Materials and Finishes; 2020.
G. BHMA A156.9 - Cabinet Hardware; 2020.
H. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2024.
I. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
J. MIA (DSDM) - Dimensional Stone Design Manual, Version VIII; 2016.
K. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
L. PS 1 - Structural Plywood; 2023.
M. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for the following:
   1. Anchors and fasteners.
   2. Adhesives.
   3. Shop finishing materials.
   4. Fire retardant treatment.
   5. Wood preservative treatment.
C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories. Include the following:
   1. Information required by AWI/AWMAC/WI (AWS).
   2. Dimensioned plans, elevations, and sections.
   3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
   4. Show locations and sizes of cutouts and holes for items installed in architectural woodwork.
D. Samples: Thsamples of each of the following:
   1. Plastic Laminates: 12 by 12 inches, for each type, color, pattern, and surface finish.
   2. Transparent Wood Finishes:
      a. Standing and Running Trim: 4 inches by 12 inches for each species, cut, and finish; finish on one side and one edge.

b. Door Frames and Borrowed Lite Frames: 4 inches by 12 inches for each species, cut, and finish; finish on one side and one edge.
c. Wood Cabinets and Millwork: 12 by 12 inches sample for each species, cut, and finish.

3. Solid Surfacing: 4 by 4 inches, for each type, color, pattern, and finish.
4. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.
5. Wood Veneer Panel Products: 12 by 12 inches sample for each type and finish.
6. Lumber and Panel Products for Field-applied Opaque Finish: 4 inches wide by 12 inches long for lumber and 12 by 12 inches for panels.
   a. Unfinished.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
B. Single Source Responsibility: Provide and install interior architectural woodwork from single fabricator.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with AWI/AWMAC/WI (AWS).
B. Do not deliver interior architectural woodwork until painting and similar finish operations that might damage woodwork have been completed in installation areas.
C. Store woodwork in installation areas or in areas with the same environmental conditions; temperature and humidity conditions in storage areas shall be at the same levels planned for occupancy.
D. Protect units from moisture damage.

1.07 FIELD CONDITIONS

A. During and after installation of architectural woodwork, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.
B. Particle Board: ANSI A208.1, Grade M-2.
C. Medium Density Fiberboard (MDF): ANSI A208.2, Grade 130.
D. Hardwood Plywood: HPVA HP-1.
E. Softwood Plywood: PS 1.
F. Fire Retardant Treatment:
   1. Manufacturers:
      a. Lonza Group: www.wolmanizedwood.com.
      b. Hoover Treated Wood Products, Inc: www.frtw.com.
      c. Koppers, Inc: www.koppersperformancechemicals.com.
      d. Viance, LLC: www.treatedwood.com.
      e. Substitutions: See Section 01 6000 - Product Requirements.
   2. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
      a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
G. Preservative Treatment:
   1. Manufacturers:
      a. Lonza Group: www.wolmanizedwood.com.
      b. Hoover Treated Wood Products, Inc: www.frtw.com.

c. Koppers Performance Chemicals, Inc: www.koppersperformancechemicals.com.
d. Viance, LLC: www.treatedwood.com.
e. Substitutions: See Section 01 6000 - Product Requirements.

2. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
b. Treat lumber in contact with masonry or concrete.
c. Treat lumber in other locations as indicated.

3. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
b. Treat plywood in contact with masonry or concrete.
c. Treat plywood at countertop subtops at sinks or other wet locations.
d. Treat plywood in other locations as indicated.

4. Preservative Pressure Treatment of Lumber in Contact with Soil: AWPA U1, Use Category UC4A, Commodity Specification A using waterborne preservative.

5. Preservative for Field Application to Cut Surfaces: As recommended by manufacturer of factory treatment chemicals for brush-application in the field.

2.02 LAMINATE MATERIALS

A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as indicated or recommended for specific applications.
1. Manufacturers:
a. Wilsonart: www.wilsonart.com.
b. Substitutions: Not permitted.
2. Colors, Patterns, and Finishes:
a. PL2 Laminart; 9301 - J Volcano, Shoji Finish..

B. Low Pressure Decorative Laminate (LPDL): Melamine resin, NEMA LD 3, Type VGL (0.20 inch thick) laminate panels; thermally fused.
1. Manufacturers:
a. Panolam Industries International, Inc.: www.panolam.com.
b. Wilsonart: www.wilsonart.com.
c. Substitutions: See Section 01 6000 - Product Requirements.
2. Color: White unless otherwise indicated.

C. Edgebanding: Rigid PVC extrusions, flat shaped, smooth texture, through color with satin finish. Width to match component thickness. Match adjacent laminate in color, pattern, and finish.
1. 0.118 inch (3 mm) thick at doors, drawer fronts, and countertops.
2. 0.039 inch (1 mm) thick elsewhere, including exposed exterior cabinet members, top edges of drawer boxes, adjustable shelves, and interior panels.

2.03 SOLID SURFACING

A. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous and non-porous; no surface coating; color and pattern consistent throughout thickness.
1. Manufacturers:
a. E. I. du Pont de Nemours and Company (Dupont); Corian: www.corian.com.
b. Substitutions: Not permitted.
2. Colors, Patterns, and Finishes:
a. SS1 Dupont, Corian; Silver Birch..

2.04 ACCESSORIES

A. Support Faming, Grounds, and Concealed Blocking: Refer to Section 06 1000 - Rough Carpentry.

B. Stain and Finishing Materials: In compliance with AWI/AWMAC/WI (AWS), unless noted otherwise.

C. Adhesives: Type recommended by fabricator to suit application.
   1. Do not use adhesives that contain urea formaldehyde.
   2. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
      a. Wood Glues: 30 g/L.
      b. Contact Adhesive: 250 g/L.

D. Fasteners: Size and type to suit application.

E. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.

F. Concealed Joint Fasteners: Threaded steel.

2.05 HARDWARE

A. Cabinet Hardware, General: BHMA A156.9, types as indicated for quality grade specified.
   1. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated. Unless otherwise indicated, provide the following finish:
      a. Satin Chrome: BHMA 626.
   2. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

B. Hinges: Semiconcealed type, 5 knuckle, institutional grade, hospital tip, 2-3/4 inch overlay, 270 opening angle, 3 way adjustment, 0.095 inch gage, steel with satin finish, Grade 1.
   1. Manufacturers:
      a. Grass America Inc: www.grassusa.com.
      b. Hafele America Co.: www.hafele.com.
      c. Rockford Hinge; Five Knuckle Overlay Hinge, part no. 374: www.rockfordprocesshingesandhardware.com.
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. Number of Hinges:
      a. Provide two (2) hinges for doors less than 36 inches high.
      b. Provide three (3) hinges for doors 37 inches to 54 inches high.
      c. Provide four (4) hinges for tall cabinet doors 55 inches to 84 inches high.

C. Drawer Slides: Zinc-plated, steel ball-bearing slides.
   1. Standard Duty, Grade 1:
      a. Self-closing, side mounted and extending under bottom edge of drawer.
      b. Locations: For drawers not more than 3 inches high and 24 inches wide.
   2. Heavy Duty, Grade 1HD-100:
      a. Self-closing, side or bottom mounted; full-extension type.
      b. Locations: For drawers not more than 6 inches high and 24 inches wide.
   3. Heavy Duty, Grade 1HD-200:
      a. Self-closing, side or bottom mounted; full-extension type.
      b. Locations: For drawers more than 6 inches high or 24 inches wide.
   4. Manufacturers:
      a. Accuride International, Inc: www.accuride.com.
      b. Grass America Inc: www.grassusa.com.
      c. Hafele America Co.: www.hafele.com.
      d. Knape & Vogt Manufacturing Company: www.knapeandvogt.com.
      e. Substitutions: See Section 01 6000 - Product Requirements.

D. Back-Mounted Pulls:
   1. Product:
      a. Hafele America Co.; Item No. 117.50.610, Wire Handle, Matt Stainless Steel: www.hafele.com.
         1) 110mm (4 inches nominal) Width.

b. Substitutions: See Section 01 6000 - Product Requirements.

E. Catches: Magnetic catches, BHMA A156.9, B03141.
1. Available Product:
a. Hafele America Co.; Model 246.26.702: www.hafele.com.

F. Door and Drawer Silencers: BHMA A156.16, L03011.

G. Adjustable Shelf Supports: Standard side-mounted system using multiple holes for pin supports and coordinated shelf rests, satin chrome finish, for nominal 1 inch spacing adjustments.
1. BHMA A156.9, B04013.

H. Adjustable Shelf Supports: Standard back-mounted system using surface mounted metal shelf standards and coordinated cantilevered shelf brackets, satin chrome finish, for nominal 1 inch spacing adjustments.
1. BHMA A156.9, B04102; with shelf brackets, B04112.

I. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with satin finish.
1. Door Locks: BHMA A156.11, E07121.
2. Drawer Locks: BHMA A156.11, E07041.
3. Provide minimum of 2 keys per lock and 4 master keys.
4. Provide on all drawers and doors, unless otherwise indicated.
5. Key all cabinets within a room the same, key all rooms differently.

J. Grommets for Cable Passage: 2-1/2 inch OD, solid brass grommets and matching caps with slot for wire passage.
1. Color: Satin Nickel.
2. Available Product:
a. Doug Mockett & Company Inc.; MM6 Series: www.mockett.com.

K. Coat Rod and Brackets:
1. Rod:
a. Material: Steel Tubing.
b. Outside Diameter: 1-5/16 inches.
c. Wall Thickness: 0.106 inches.
d. Length: As indicated.
2. Brackets: Wall flanges; steel.
3. Finish: Chrome.
4. Available Product:
a. Knape & Vogt; KV 770 Series Rod with 764 Wall Flanges: www.knapeandvogt.com.

L. Countertop Support Brackets:
1. Tee-Shaped Brackets: Fabricated from 6063-T6 extruded aluminum 2 inch by 3 inch by 3/16 inch Tee.
a. Finish: Black.
b. Size: 18 inch support unless otherwise indicated.
1) Manufacturers:
(a) Rakks Model EH 1818 ; Rangine Corp.: www.rakks.com.
(b) Or equal by A&M Hardware, Inc.; www.aandmhardware.com.
(c) Substitutions: See Section 01 6000 - Product Requirements.
c. Where concealed flush mount is indicated on Drawings, provide the following:
1) Manufacturers:
(a) Rakks Model EH1818-FM; Rangine Corp.: www.rakks.com.
(b) Or equal by A&M Hardware, Inc.; www.aandmhardware.com.
(c) Substitutions: See Section 01 6000 - Product Requirements.

M. Z-Clips: 6063-T6 extruded aluminum z clips. Sized as required to support applied loads.
1. Manufacturers:
a. Monarch Metal Fabrication: www.monarchmetal.com.
b. Eagle Mouldings Inc.: www.eagle-aluminum.com.
c. Substitutions: See Section 01 6000 - Product Requirements.

N. Aluminum Channels and Angles: 6061-T6 extruded aluminum channels, with sharp corners, mill finish, size as required or indicated on Drawings.

O. Wire Manager
   1. Flexible cable clip wire manager, directly mounted to underside of worksurface.
   2. Basis of Design:
      a. Mockett; Flex Wire Manager, WM38092; www.mockett.com.
      b. Substitutions: See Section 01 6000-Product Requirements.
   3. Color: Grey
   4. Size: As Required for Complete Installation

2.06 FABRIC WRAPPED TACKABLE PANELS

A. Fabric-Faced Fiberboard Tackboards: Fabric factory laminated to ½-inch (13mm) thick fiberboard backing; ASTM E 84.
   1. Fiberboard: ASTM 209 – Standard Cellulosic Fiber Insulation Board meeting the following requirements:
      a. Thickness: 1/2”
      b. Density: 34-40 lbs. / Cu. Ft.
      c. Tensile Strength: Parallel 400-700 psi; Transverse 600-900 psi.
      d. Noise Reduction Coefficient (NRC): 0.20
      e. Flame Spread Rating: 0-25 (Class A)
      f. Basis of Design: Homasote Design Wall 500, using fabric specified below.
         1) Basis of Design Manufacturer: Homasote Company, 932 Lower Ferry Street, West Trenton, NJ 08628. 1-800-257-9491.
         2) Substitutions: See Section 01 6000-Product Requirements.
   2. Xorel Fabric: Flame spread index of 25 or less when tested according to ASTM E 84.
      a. Fabric: Carnegie; Xorel Meteor 6427; www.carnegiefabrics.com/carnegie-xorel.
      b. Weight:
      c. Width: 56 inches
      d. Fiber: 100% IFR Xorel
      e. Backing: Unfinished
      f. Finish: None.
      g. Fire Test: ASTM E84 Class A
      h. Color: 2001 (Grey).

2.07 FABRICATION

A. General:
   1. Fabricate woodwork to dimensions, profiles, and details indicated.
   2. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation.
   3. Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and fixtures and fittings. Verify locations of cutouts from on-site dimensions. Seal cut edges.
      a. Locate openings accurately and use templates to produce accurately sized and shaped openings.
   4. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
   5. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
      a. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
      b. Cap exposed plastic laminate finish edges with material of same finish and pattern, unless otherwise indicated.
   6. Fire Retardant Wood Materials:
      a. Provide UL (DIR) listed and approved identification on fire retardant treated material.
      b. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.

B. Cabinets and Millwork:

1. Assembly: Shop assemble cabinets and millwork for delivery to site in units easily handled and to permit passage through building openings.
2. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

2.08 PLASTIC LAMINATE CABINETS AND MILLWORK

A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.
B. Casework Construction Type: Frameless.
C. Door and Drawer Style: Flush Overlay.
D. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
E. Exposed Surfaces:
   1. Horizontal Surfaces: Grade HGL (0.039 inch thick).
   2. Vertical Surfaces: Grade VGS (0.028 inch thick).
   3. Door and Drawer Edges:PVC edge banding, 0.118 inch (3mm) thick, matching laminate in color, pattern, and finish .
   4. Other Edges: PVC edge banding, 0.039 inch (1mm) thick, matching laminate in color, pattern, and finish
   5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.
F. Semi-exposed Surfaces:
   1. For semiexposed backs of panels with exposed surfaces: Grade VGS (0.028 inch thick).
   2. Surfaces Other Than Drawer Bodies: Low pressure decorative laminate.
      a. Edges of Low Pressure Decorative Laminate Shelves: PVC edge banding, 0.039 inch (1mm) thick, matching laminate in color, pattern, and finish.
   3. Surfaces of Drawer Subfronts, Backs, and Sides: Low pressure decorative laminate.
   4. Cores of Drawer Subfronts, Backs, and Sides: Hardwood veneer plywood.
   5. Drawer Bottoms: Hardwood veneer plywood.
G. Concealed Backs of Panels with Exposed or Semi-exposed Surfaces: Grade BKL (0.020 inch thick).
H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
   1. Drawer Construction Method: Multiple dovetailed or doweled.
I. All cabinets and millwork shall be fabricated with balance construction.
J. Cabinet and millwork sizes, layouts, and configurations: As indicated on Drawings.

2.09 MISCELLANEOUS ITEMS

A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.
B. Closet and Utility Shelving:
   1. Shelf Material: 3/4 inch thick.
      a. Horizontal Surfaces: Low-Pressure Decorative Laminate, NEMA LD 3, Thermoset decorative faces.
      b. Core: Particle board, medium density fiberboard (MDF), or plywood.
      c. Shelf Edges: PVC or polyester edge banding.
   2. Cleats: 3/4-inch solid lumber.

2.10 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.
B. Field Applied Opaque Finishes:
   1. Apply wood filler in exposed nail and screw indentations and sand smooth.
   2. Shop prime with one coat of wood primer as specified in Section 09 9123 - Interior Painting.
   3. Refer to Section {\id\#1000020} - {\t\#1000020} for field painting.
C. Shop Applied Transparent Finishes:

1. On items to receive transparent finishes, use wood filler matching or blending with surrounding surfaces and of types recommended for applied finishes.
2. Finish work in accordance with AWI/AWMAC/WI (AWS), Section 5 - Finishing for grade specified and as follows:
   a. Transparent Finishes:
      1) Provide one of the following finishes:
         (a) System - 5, Varnish, Conversion.
         (b) System - 9, UV Curable, Acrylated Epoxy, Polyester or Urethane.
         (c) System - 10, UV Curable, Water-based.
         (d) System - 11, Polyurethane, Catalyzed.
      2) Stain: To match Architect's samples.
      3) Sheen: Satin.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of backing and support framing.
B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 PREPARATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that architectural woodwork can be supported and installed as indicated.
B. Condition all interior architectural woodwork to temperature and humidity conditions in installation areas for not less than 72 hours prior to installation.
   1. Temperature and humidity conditions shall be same levels planned for occupancy.

3.03 INSTALLATION - GENERAL

A. Install work in accordance with AWI/AWMAC/WI (AWS) requirements for grade indicated.
B. Install architectural woodwork level, plumb, true in line, and without distortion.
   1. Shim as required with concealed shims.
   2. Install level and plumb to a tolerance of 1/8 inch in 96 inches
C. Scribe and cut architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

3.04 CABINET AND MILLWORK INSTALLATION

A. Set and secure custom cabinets and millwork in place, assuring that they are rigid, plumb, and level.
B. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned.
   1. Adjust hardware to center doors and drawers in openings and to provide easy and smooth operation.
C. Use fixture attachments in concealed locations for wall mounted components.
   1. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips, or No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
E. Secure cabinets to floor using appropriate angles and anchorages.

3.05 COUNTERTOP INSTALLATION

A. Install countertops level; shim where required.
   1. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum.
   2. Do not exceed 1/64-inch difference between planes of adjacent units.
B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
C. Attach plastic laminate countertops to substrates using concealed screws and fasteners.

D. Attach solid surfacing countertops to substrates with adhesive according to solid surfacing manufacturer's written instructions.
E. Joints: Keep to a minimum; seal with manufacturer's recommended joint adhesive.
   1. Joints shall be inconspicuous in appearance, smooth, and without voids.
   2. Use adhesive in color to match countertop; form seams according to manufacturer's written instructions.
F. Install back and end splashes to countertop and walls with manufacturer’s recommended adhesive.
G. Apply sealant between back and end splashes and wall.
   1. Refer to Section 07 9200 - Joint Sealants for joint sealant.

3.06 FABRIC WRAPPED TACKABLE PANEL INSTALLATION

A. Fabric shall be applied using Manufacturer's recommended adhesive. Allow adhesive that appears through the fabric to dry; when dry, remove with a dry brush. if adhesive removal is required, used only the method recommended by the manufacturer for this express purpose.
B. Install units in locations and at mounting heights indicated and in accordance with the manufacturer's instructions. Keep perimeter lines straight, plumb, and level. Provide grounds, clips, backing materials, adhesives, brackets, anchors, metal trim, and accessories necessary for a complete installation.
C. Place fabric panels in the order cut from rolls. Apply to backing in same sequential order as they will be installed. Do not use sections of material with obvious defects.

3.07 ADJUSTING

A. Adjust installed work.
B. Adjust moving or operating parts to function smoothly and correctly.

3.08 REPAIRING AND CLEANING

A. Repair damaged and defective architectural woodwork, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural woodwork.
B. Clean all architectural woodwork, including, but not limited to, casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 06 4023

SECTION 07 1113 - BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Bituminous dampproofing.
B. Protection boards.

1.02 REFERENCE STANDARDS

A. ASTM D1187/D1187M - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal; 1997 (Reapproved 2018).
B. ASTM D1227/D1227M - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing; 2013 (Reapproved 2024).
C. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide properties of primer, bitumen, and mastics.
C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with at least 5 years of documented experience.

1.05 FIELD CONDITIONS

A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application until dampproofing has cured.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers:
1. BASF Corp., Master Builders Solutions; www.master-builders-solutions.basf.us.
2. Carlisle Coatings and Waterproofing; www.carlisleccw.com.
3. The Euclid Chemical Company; www.euclidchemical.com.
4. Henry Corp.; www.henry.com.
5. Karnak Corp.; www.karnakcorp.com.
6. Lambert Corp.; www.lambertusa.net.
7. W. R. Meadows, Inc.; www.wrmeadows.com.
8. Substitutions: See Section 01 6000 - Product Requirements.

2.02 BITUMINOUS DAMPPROOFING

A. Bituminous Dampproofing: Cold-applied water-based emulsion; asphalt with mineral colloid or chemical emulsifying agent; with or without fiber reinforcement; asbestos-free; suitable for application on vertical and horizontal surfaces.
1. Composition - Vertical Application: ASTM D1227/D1227M Type III or ASTM D1187/D1187M Type I.
2. Composition - Horizontal and Low-Slope Application: ASTM D1227/D1227M Type II or III.
3. VOC Content: Not more than permitted by local, State, and federal regulations.
4. Applied Thickness: 1/16 inch, minimum, wet film.
B. Primers, Mastics, and Related Materials: Type as recommended by dampproofing manufacturer.

2.03 ACCESSORIES

A. Protection Board: 1/8 inch thick bitumen impregnated glass fiberboard.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions are acceptable prior to starting this work.

B. Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of dampproofing system.
C. Verify that items penetrating surfaces to receive dampproofing are securely installed.

3.02 PREPARATION

A. Protect adjacent surfaces not designated to receive dampproofing.
B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.
C. Do not apply dampproofing to surfaces unacceptable to manufacturer.
D. Apply mastic to seal penetrations, small cracks, or minor honeycombs in substrate.

3.03 APPLICATION

A. Perform this work in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
B. Prime surfaces in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
C. Prime surfaces at a rate approved by manufacturer for application indicated, and allow primer to dry thoroughly.
D. Apply bitumen with roller or spray application; apply two coats.
E. Seal items watertight with mastic, that project through dampproofing surface.
F. Place protection board directly over dampproofing, butt joints, and adhere to tacky dampproofing.
G. Scribe and cut boards around projections, penetrations, and interruptions.

END OF SECTION 07 1113

SECTION 07 1300 - SHEET WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sheet Waterproofing:
   1. Self-adhered sheet waterproofing membrane.
   2. Drainage panels.

1.02 RELATED REQUIREMENTS

A. Divisions 22 and 32 for piped subdrainage system.

1.03 ABBREVIATIONS

A. HDPE - High-Density Polyethylene.

1.04 REFERENCE STANDARDS

A. ASTM C836/C836M - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course; 2018 (Reapproved 2022).
B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).
C. ASTM D570 - Standard Test Method for Water Absorption of Plastics; 2022.
D. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting; 2018.
E. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds; 1998 (Reapproved 2017).
F. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).
G. ASTM D1876 - Standard Test Method for Peel Resistance of Adhesives (T-Peel Test); 2008 (Reapproved 2023).
H. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.
I. ASTM D5295/D5295M - Standard Guide for Preparation of Concrete Surfaces for Adhered (Bonded) Membrane Waterproofing Systems; 2018.
J. ASTM D5385/D5385M - Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes; 2025.
K. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.
L. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a (Reapproved 2025).
M. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint and crack sealants, drainage panel, and drainage panel collector.
C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
D. Samples: Three samples of each of the following:
   1. Self-adhered sheet waterproofing membrane; approximately 4 inches by 4 inches.
   2. Drainage panel; approximately 8 inches by 8 inches.
   3. Drainage panel collector; 12 inch length.
E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and acceptable installation temperatures.
F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Membrane Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 5 years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years of documented experience.

1.07 MOCK-UP

A. Construct mock-up consisting of 100 sq ft of vertical waterproofed panel; to represent finished work including internal and external corners, seam jointing, and drainage panel.

B. Locate where directed.

C. Mock-up may remain as part of this Work.

1.08 FIELD CONDITIONS

A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for waterproofing failing to resist penetration of water.

PART 2 PRODUCTS

2.01 MEMBRANE MATERIALS

A. Self-Adhered Sheet Membrane: 56 mil self-adhesive rubberized asphalt laminated to 4 mil polyethylene or HDPE film.

1. Properties and Performance Requirements:
   a. Tensile Strength:
      1) Film: 5,000 psi, minimum, measured in accordance with ASTM D882 and at grip-separation rate of 2 inches per minute.
      2) Membrane: 325 psi, minimum, measured in accordance with ASTM D412 Method A, using die C and at spindle-separation rate of 2 inches per minute.
   b. Elongation at Break: 300 percent, minimum, measured in accordance with ASTM D412.
   c. Water Vapor Permeance: 0.05 perm, maximum, measured in accordance with ASTM E96/E96M.
   d. Low Temperature Flexibility: Unaffected when tested in accordance with ASTM D1970/D1970M at minus 20 degrees F, 180 degree bend on 1 inch mandrel.
   e. Crack Cycling: Unaffected when tested according to ASTM C836/C836M at minus 25 degrees F.
   f. Peel Strength: 9 pounds per inch, minimum, when tested according to ASTM D903.
   g. Lap Adhesion Strength: 5 lb per inch, minimum, when tested in accordance with ASTM D1876.
   h. Puncture Resistance: 48 pounds, minimum, measured in accordance with ASTM E154/E154M.
   i. Water Absorption: 0.1 percent increase in weight, maximum, measured in accordance with ASTM D570, 24 hour immersion.
   j. Hydrostatic Resistance: Resists the weight of 230 feet when tested according to ASTM D5385/D5385M.
2. Products:
   a. Carlisle Coatings & Waterproofing Inc; MiraDRI 860/861: www.carlisleccw.com.
   b. CETCO; Envirosheet: www.cetco.com.
   c. GCP Applied Technologies; Bituthene System 4000: www.gcpat.com.
   d. Polyguard Products, Inc.; 650 Membrane: www.polyguardproducts.com.
   e. W. R. Meadows, Inc.; MEL-ROL: www.wrmeadows.com.
   f. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ACCESSORIES

A. Provide all related auxiliary materials as recommended by waterproofing sheet membrane manufacturer for complete installation; materials shall be compatible with sheet waterproofing and substrates. Includes, but is not limited to, the following:
   1. Surface conditioners and primers.
   2. Crack fillers and sealants; comply with requirements of Section 07 9200 - Joint Sealants.
   3. Seaming materials.
   4. Liquid membranes and flexible flashings.
   5. Cants.

B. Drainage Panel: Drainage layer with geotextile filter fabric on earth side.
   1. Composition: Dimpled polystyrene, polyethylene, or polypropylene core; polypropylene filter fabric.
   2. Properties and Performance Requirements:
      a. Thickness: 0.40 inches.
      b. Roll Size: 48 inches wide by 50 feet.
      c. Compressive Strength: 15,000 psi, minimum, per ASTM D1621.
      d. Water Flow Rate: 20 gpm per ft, minimum
   3. Products:
      a. Carlisle Coatings & Waterproofing Inc; MiraDRIAN 6200: www.carlisleccw.com.
      b. CETCO; Aquadrain 15X: www.cetco.com.
      c. GCP Applied Technologies; Bituthene System 4000: www.gcpat.com.
      d. Polyguard Products, Inc.; Polyflow 15: www.polyguardproducts.com.
      e. W. R. Meadows, Inc.; MEL-DRAIN 7955: www.wrmeadows.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.

C. Drainage Panel Collector: Subsurface drainage panel collector wrapped with geotextile filter fabric.
   1. Collects water from darainage panels and directs water flow to piped subdrainage system provided by others.
   2. Provide all associated components to connect drainage panel collector to piped subdrainage system.
   3. Properties and Performance Requirements:
      a. High Profile Thickness: 1 inch.
      b. Low Profile Thickness: 0.40 inches.
      c. Roll Size: 24 inches wide by 50 feet.
      d. Compressive Strength: 9,000 psi, minimum, per ASTM D1621.
      e. Water Flow Rate:
         1) High Profile: 100 gpm per ft., minimum.
         2) Low Profile: 21 gpm per ft., minimum.
   4. Products:
      a. Carlisle Coatings & Waterproofing Inc; Side/Endout Drain Connector: www.carlisleccw.com.
      b. CETCO; Aquadrain 100DB: www.cetco.com.
      c. GCP Applied Technologies; Hydroduct: www.gcpat.com.
      d. Polyguard Products, Inc.; Totalflow: www.polyguardproducts.com.
      e. W. R. Meadows, Inc.; MEL-DRAIN TOTAL-DRAIN: www.wrmeadows.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions are acceptable prior to starting this work.

B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.

C. Verify items that penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION

A. Protect adjacent surfaces from damage not designated to receive waterproofing.
B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions; vacuum substrate clean.
C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.
D. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.
E. Seal moving cracks with sealant and non-rigid filler, using procedures recommended by sealant and waterproofing manufacturers.
F. Prepare building expansion joints at locations as indicated on drawings.
G. Surfaces for Adhesive Bonding: Apply surface conditioner at a rate recommended by manufacturer, and protect conditioner from rain or frost until dry.
H. Concrete Surfaces for Adhesive Bonding: Prepare concrete substrate according to ASTM D5295/D5295M.
    1. Remove substances that inhibit adhesion including form release agents, curing compounds admixtures, laitance, moisture, dust, dirt, grease and oil.
    2. Repair surface defects including honeycombs, fins, tie holes, bug holes, sharp offsets, rutted cracks, ragged corners, deviations in surface plane, spalling and delaminations, as described in the reference standard.
    3. Remove and replace areas of defective concrete as specified in Section 03 3000.
    4. Prepare concrete for adhesive bonded waterproofing using mechanical or chemical methods described in the referenced standard.
    5. Test concrete surfaces as described in the referenced standards. Verify surfaces are ready to receive adhesive bonded waterproofing membrane system.

3.03 INSTALLATION - MEMBRANE

A. Install membrane waterproofing in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
B. Roll out membrane, and minimize wrinkles and bubbles.
C. Self-Adhering Membrane: Remove release paper layer, and roll out onto substrate with a mechanical roller to provide full contact bond.
D. Overlap edges and ends, minimum 3 inches, seal permanently waterproof by method recommended by manufacturer.
E. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.
F. Weather lap joints on sloped substrate in direction of drainage, and seal joints and seams.
G. Install building expansion joints at locations as indicated on drawings.
H. Flexible Flashings: Seal items watertight that penetrate through waterproofing membrane with flexible flashings.
I. Seal membrane and flashings to adjoining surfaces.

3.04 INSTALLATION - DRAINAGE PANEL

A. Install drainage panels and drainage panel collectors in accordance with manufacturer's instructions
B. Place drainage panel directly against membrane, lap joints, place to encourage drainage downward. Scribe and cut boards around projections, penetrations, and interruptions.
C. Tie-in drainage panel collector to bottom edges of drainage panels.
    1. Connect drainage panel collector to piped subdrainage system provide by others.
        a. Refer to Divisions 22 and 32 for piped subdrainage system

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.

B. Waterproofing will be considered defective if it does not pass tests and inspections.

1. Correct deficiencies in or remove and replace waterproofing that does not comply with requirements.

3.06 PROTECTION

A. Protect waterproofing from damage and wear during construction period.

B. Repair or remove and replace damaged waterproofing that does not comply with requirements.

END OF SECTION 07 1300

SECTION 07 2100 - THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Board insulation.
B. Batt insulation.

1.02 RELATED REQUIREMENTS

A. Section 04 2000 - Unit Masonry: Cavity wall insulation specified as part of the masonry.

1.03 REFERENCE STANDARDS

A. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.
B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
C. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).
D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
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; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Product Coordination and Limitations: Provide products that when combined with materials and components of other sections, form exterior wall assemblies as detailed on Drawings, that comply with NFPA 285 testing and acceptance criteria.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
C. NFPA 285 Documentation: For each product, submit documentation listing compatible materials and components that when used together in wall assemblies as detailed on Drawings, comply with NFPA 285 testing and acceptance criteria.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than 5 years of documented experience.

1.07 FIELD CONDITIONS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 BOARD INSULATION MATERIALS

A. Extruded Polystyrene Board Insulation: Extruded polystyrene board; ASTM C578; with either natural skin or cut cell surfaces, and the following characteristics:
   1. Type: Type IV.
   2. Compressive Strength: 25 psi; ASTM D1621.
   3. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
   4. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
   5. R-Value (RSI-value); 1 inch of material at 75 degrees F: 5 (0.88), minimum.
   6. Insulation shall be an approved component of an NFPA 285 tested exterior wall assembly as detailed on Drawings; tested in accordance with, and complying with the acceptance criteria, of NFPA 285.
   7. Board Edges: Square.

8. Water Absorption, Maximum: 0.3 percent, by volume.
9. Products:
   a. DiversiFoam Products: CertiFoam 25 SE; www.diversifoam.com.
   b. Dow Building Solutions, Dow Chemical Company; Styrofoam Brand Square Edge Insulation: www.dow.com.
   c. Kingspan Insulation LLC; GreenGuard XPS TYPE IV 25 PSI: www.trustgreenguard.com.
   d. Owens Corning; Foamular 250: www.owenscorning.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.

B. Extruded Polystyrene Board Insulation - High Load: Extruded polystyrene board; ASTM C578; with either natural skin or cut cell surfaces, and the following characteristics:
1. Type: Type VII.
2. Compressive Strength: 60 psi; ASTM D1621.
3. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
4. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
5. R-Value (RSI-value); 1 inch of material at 75 degrees F: 5 (0.88), minimum.
6. Insulation shall be an approved component of an NFPA 285 tested exterior wall assembly as detailed on Drawings; tested in accordance with, and complying with the acceptance criteria, of NFPA 285.
7. Board Edges: Square.
8. Water Absorption, Maximum: 0.3 percent, by volume.
9. Products:
   a. DiversiFoam Products: CertiFoam 60; www.diversifoam.com.
   b. Dow Building Solutions, Dow Chemical Company; Styrofoam Highload 60: www.dow.com.
   c. Kingspan Insulation LLC; GreenGuard Type VII XPS: www.trustgreenguard.com.
   d. Owens Corning; Foamular 600: www.owenscorning.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.

C. Extruded Polystyrene (XPS) Board Insulation: Complies with ASTM C578 with either natural skin or cut cell surfaces.
1. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
2. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
3. Type and Thermal Resistance, R-value: Type IV, 5.0 (0.88), minimum, per 1 inch thickness at 75 degrees F mean temperature.
4. Complies with fire resistance requirements indicated on drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
5. Board Edges: Square.
6. Type and Water Absorption: Type IV, 0.3 percent by volume, maximum, by total immersion.
7. Products:
   a. DuPont de Nemours, Inc; Styrofoam Brand Cavitymate Plus : building.dupont.com/#sle.
   b. Kingspan Insulation LLC; GreenGuard XPS Type IV, 25 psi: www.kingspan.com/#sle.
   c. Owens Corning Corporation; FOAMULAR Type CW25 Extruded Polystyrene (XPS) Insulation: www.ocbuildingspec.com/#sle.
   d. Substitutions: See Section 01 6000 - Product Requirements.

2.02 BATT INSULATION MATERIALS

A. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 50 or less, when tested in accordance with ASTM E84.
3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.

4. Formaldehyde Content: Zero.
5. Thermal Resistance: R-value of 15 unless otherwise indicated.
6. Thickness: 3-1/2 inch, unless otherwise indicated.
7. Facing: Unfaced, Type 1.
8. Products:
   a. CertainTeed Corporation; CertaPro AcoustaTherm Batts: www.certainteed.com.
   b. Johns Manville; Formaldehyde-Free Fiberglass Insulation: www.jm.com.
   c. Knauf Insulation; EcoBatt Insulation with ECOSE Technology: www.knaufinsulation.com.
   d. Owens Corning Corporation; EcoTouch PINK FIBERGLAS Insulation: www.owenscorning.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.

B. Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced.
1. Flame Spread Index: 0 (zero) when tested in accordance with ASTM E84.
2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
3. Facing: Unfaced, Type 1.
4. At Metal Studs and Miscellaneous Locations:
   a. Density: 2.5 pcf, minimum..
   b. Thermal Resistance: R-value of 3.7 per inch.
   c. Thickness: 3-1/2 inches, unless otherwise indicated.
   d. Products:
      1) Johns Manville; Mineral Wool Sound Attenuation Fire Batts (SAFB): www.jm.com..
      2) Rockwool; Comfortbatt: www.rockwool.com.
      3) Thermafiber Inc., an Owens Corning Company; UltraBatt: www.owenscorning.com.
      4) Substitutions: See Section 01 6000 - Product Requirements.

2.03 ACCESSORIES

A. Insulation Fasteners: Impaling clip of unfinished steel with self-locking washer retainer, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.
1. Manufacturers:
   a. Gemco: www.gemcoinsulation.com.
   b. AGM Industries, Inc.
   c. Substitutions: See Section 01 6000 - Product Requirements.

B. Wire Mesh: Galvanized steel, hexagonal wire mesh.

C. Adhesive: Type recommended by insulation manufacturer for application.

D. Formed-in-Place Foam Sealant: Two-component polyurethane sealant.
1. Gun-applied and straw-applied products.
2. Thermal Resistance (R) Value: 6.5 per inch.
3. Maximum gap width: 3 inches.
4. Manufacturer:
   a. Dow Building Solutions, Dow Chemical Company; Froth-Pak Foam Sealant: www.dow.com.
   b. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

C. Verify board insulation materials are dry, clean, and ready to receive foam-in-place sealants.

3.02 INSTALLATION - GENERAL

A. Install according to insulation manufacturers instructions.
B. Use sizes, thickness, and types as indicated on Drawings.
C. Fit insulation snugly against abutting insulation and building construction without gaps.
D. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION AT FOUNDATION PERIMETER

A. Apply adhesive to back of boards:
   1. Three continuous beads per board length.
B. Install boards vertically on foundation perimeter, unless otherwise indicated.
   1. Extend boards 24 inches, minimum, below finished floor, unless otherwise indicated.
   2. Place boards to maximize adhesive contact.
   3. Install in running bond pattern.
   4. Butt edges and ends tightly to adjacent boards and to protrusions.
C. Extend boards over expansion joints, unbonded to foundation on one side of joint.
D. Formed-in-Place Foam Sealant
   1. Apply formed-in-place foam sealant in accordance with manufacturer's instructions at the following locations:
      a. Between all board joints.
         1) Insert dispensing nozzle between boards and fill with foam sealant until bead of foam is visible at the board surface and continuous along all board joints.
      b. Between insulation board and abutting adjacent construction.
      c. Between boards and all penetrating items.
      d. Foam sealant shall be installed continuously without breaks or gaps.
   2. When complete, insulation board installation shall be continuous without air gaps, holes, or open joints and penetrations.
   3. Formed-in-place foam sealant is not required at boad insulation where foundation perimeter does not have a habitable basement, tunnels, or other open air spaces on the interior side of the foundation perimeter.

3.04 BOARD INSTALLATION AT WALLS

A. Apply adhesive to back of boards:
   1. Three continuous beads per board length.
B. Install boards horizontally on walls.
   1. Place boards to maximize adhesive contact.
   2. Install in running bond pattern.
   3. Butt edges and ends tightly to adjacent boards and protrusions.
C. Extend boards over expansion joints, unbonded to wall on one side of joint.
D. Apply formed-in-place foam sealant in accordance with manufacturer's instructions at the following locations:
   1. Between all board joints.
      a. Insert dispensing nozzle between boards and fill with foam sealant until bead of foam is visible at the board surface and continuous along all board joints.
   2. Between insulation board and abutting adjacent construction.
   3. Between boards and all penetrating items.
   4. Foam sealant shall be installed continuously without breaks or gaps.
E. When complete, insulation board installation shall be continuous without air gaps, holes, or open joints and penetrations.
F. Soffits and overhead insulation installation is similar.

3.05 BOARD INSTALLATION UNDER CONCRETE SLABS

A. Place insulation under slabs on grade after base for slab has been compacted.
B. Butt edges and ends tightly to adjacent boards; taping and foam-in-place sealant is not required.
C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

D. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

3.06 BATT INSTALLATION

A. Install insulation in accordance with manufacturer's instructions.
B. Install in wall, roof, and ceiling spaces without gaps or voids. Do not compress insulation.
C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
E. Where extra support is needed, retain insulation batts in place with wire mesh secured to framing members or adjacent construction.

3.07 INSULATION AT MISCELLANEOUS VOIDS

A. Install one or more of the following:
   1. Glass fiber batt insulation.
   2. Mineral fiber batt insulation.
   3. Formed-in-place foam sealant.
B. Install insulation to neatly fit spaces; fill voids completely without compressing insulation.

3.08 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 07 2100

SECTION 07 2423 - DIRECT-APPLIED FINISH SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Direct-Applied Finish System (DAFS) for exterior and interior soffits and ceilings.

1.02 ABBREVIATIONS

A. DAFS: Direct-Applied Finish Systems.

1.03 REFERENCE STANDARDS

A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
C. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
D. ASTM D968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive; 2017.
E. ASTM D2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity; 2015.
F. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
H. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).
I. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials; 2013.
J. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials; 2013.
K. ICC-ES AC219 - Acceptance Criteria for Exterior Insulation and Finish Systems; 2009, with Editorial Revision (2022).
L. ICC-ES AC235 - Acceptance Criteria for EIFS Clad Drainage Wall Assemblies; 2015, with Editorial Revision (2022).

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on system materials, product characteristics, performance criteria, and system limitations.
C. Shop Drawings: Indicate plans, details, joint patterns, joint details, and molding profiles.
D. Verification Samples: Submit three actual samples of selected coating on specified substrate, minimum 12 inches square, illustrating project colors and textures.
E. Manufacturer's Installation Instructions: Indicate preparation required, installation techniques, and jointing requirements.

1.05 QUALITY ASSURANCE

A. Maintain copy of specified installation standard and manufacturer's installation instructions at project site during installation.
B. Manufacturer Qualifications: Provide DAFS products from manufacturer with qualifications as follows:
   1. Member in good standing of EIMA (EIFS Industry Members Association).
   2. Manufacturer of DAFS products for not less than 5 years.
C. Installer Qualifications: Company specializing in the type of work specified and with at least 5 years of documented experience and approved by manufacturer.

1.06 MOCK-UP

A. Construct mock-up of typical DAFS application on specified substrate, size as required to include examples of all key conditions, and including flashings, joints, and edge conditions.
B. Locate mock-up where directed.
C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to project site in manufacturer's original, unopened containers with labels intact. Inspect materials and notify manufacturer of any discrepancies.
B. Storage: Store materials as directed by manufacturer's written instructions.
   1. Protect adhesives and finish materials from freezing, temperatures below 40 degrees F and temperatures in excess of 90 degrees F.
   2. Protect Portland cement based materials from moisture and humidity. Store under cover off the ground in a dry location.

1.08 FIELD CONDITIONS

A. Do not prepare or install materials in conditions other than those described in the manufacturer's written instructions.
B. Do not prepare or apply materials during inclement weather unless areas of installation are protected. Protect installed direct-applied finish system areas from inclement weather until dry.
C. Do not install coatings or sealants when ambient temperature is below 40 degrees F.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide manufacturer's standard material warranty, covering a period of not less than 5 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products:
   1. BASF Corp.; Synergy Direct Finish Systems for Soffits and Ceilings: www.basf.com.
   2. Dryvit Systems, Inc.; Direct Applied TAFs: www.dryvit.com.
   3. Parex USA, Inc.; ACF Soffit: www.parex.com.
   4. Sto Corp.; Or Equal: www.stocorp.com.
   5. Substitutions: See Section 01 6000 - Product Requirements.

2.02 DIRECT-APPLIED FINISH SYSTEM

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, when tested in accordance with ASTM E84.
B. Adhesion of Water-Resistive Coating to Substrate: For each combination of coating and substrate, minimum ensile bond strength of 15 psi, when tested in accordance with ASTM E2134 .
C. Water Penetration Resistance: No water penetration beyond the plane of the base coat after 15 minutes, when tested in accordance with ASTM E331 at 6.24 psf differential pressure.
D. Salt Spray Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 300 hours exposure in accordance with ASTM B117, using at least three samples matching intended assembly, at least 4 by 6 inches in size.
E. Freeze-Thaw Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating when viewed under 5x magnification after 10 cycles, when tested in accordance with {\rs\#1} or 16 CFR 1201.
F. Weathering Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating when viewed under 5x magnification after 2000 hours of accelerated weathering conducted in accordance with ASTM G153 Cycle 1 or ASTM G155 Cycles 1, 5, or 9.

G. Water Degradation Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 14 days exposure, when tested in accordance with ASTM D2247.
H. Mildew Resistance: No growth supported on finish coating during 28 day exposure period, when tested in accordance with ASTM D3273.
I. Abrasion Resistance Of Finish: No cracking, checking or loss of film integrity when tested in accordance with ASTM D968 with 113.5 gallons of sand.

2.03 MATERIALS

A. Finish Coating Top Coat: Water-based, air curing, acrylic or polymer-based finish with integral color and texture.
   1. Texture: Sand/Fine.
   2. Color: As selected by Architect from manufacturer's full range.
B. Base Coat: Acrylic- or polymer-modified, fiber reinforced Portland cement coating; compatible with substrate board and reinforcing mesh.
   1. Portland Cement: ASTM C150/C150M, Type I or II.
C. Reinforcing Mesh: Balanced, open weave glass fiber fabric, treated for compatibility and improved bond with coating; weight, strength, and number of layers as required by base coat manufacturer.
D. Substrate Board: Refer to Section 06 1000 - Rough Carpentry.

2.04 ACCESSORY MATERIALS

A. Primer: Primer as recommended by DAFS manufacturer for substrate and project conditions.
B. Trim: DAFS manufacturer's standard PVC trim accessories, as required for a complete project.
C. Sealant Materials: Compatible with DAFS materials and as recommended by DAFS manufacturer.
D. Exterior Soffit Vents: One piece, perforated, ASTM B221 AA DAF-45 6063 alloy, T5 temper, aluminum, with edge suitable for direct application to gypsum board and manufactured especially for soffit application. Provide continuous vent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate is sound and free of oil, dirt, other surface contaminants, efflorescence, loose materials, or protrusions that could interfere with DAFS installation and is of a type and construction that is acceptable to DAFS manufacturer. Do not begin work until substrate and adjacent materials are complete and thoroughly dry.
B. Verify that substrate surface is flat, with no deviation greater than 1/4 in when tested with a 10 ft straightedge.

3.02 PREPARATION

A. Apply primer to substrate as recommended by DAFS manufacturer for project conditions.

3.03 INSTALLATION

A. Install in accordance with DAFS manufacturer's instructions.
B. Substrate Boards: Refer to Section 06 1000 - Rough Carpentry.
C. Base Coat: Apply in thickness as necessary to fully embed reinforcing mesh, wrinkle free, including back-wrap at terminations of DAFS. Install reinforcing fabric as recommended by DAFS manufacturer.
   1. Lap reinforcing mesh edges and ends a minimum of 2-1/2 inches.
   2. Allow base coat to dry a minimum of 24 hours before next coating application.
D. Apply finish coat after base coat has dried not less than 24 hours and finish to a uniform texture and color.
E. Finish Coat Thickness: As recommended by manufacturer.

F. Seal control and expansion joints within the field of exterior finish and insulation system, using procedures recommended by sealant and finish system manufacturers.

3.04 CLEANING

A. Clean DAFS surfaces and work areas of foreign materials resulting from DAFS operations.

3.05 PROTECTION

A. Protect completed work from damage and soiling by subsequent work.

END OF SECTION 07 2423

SECTION 07 2500 - WEATHER BARRIERS

PART 2 PRODUCTS

END OF SECTION 07 2500

SECTION 07 2726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Vapor-retarding, fluid-applied air barriers.

1.02 DEFINITIONS

A. Weather Barrier: Assemblies that form either water-resistive barriers, air barriers, or vapor retarders.

B. Air Barrier: Air tight barrier made of material that is relatively air impermeable but water vapor permeable, both to the degree specified, with sealed seams and with sealed joints to adjacent surfaces. Note: For the purposes of this specification, vapor impermeable air barriers are classified as vapor retarders.

C. Vapor Retarder: Air tight barrier made of material that is relatively water vapor impermeable, to the degree specified, with sealed seams and with sealed joints to adjacent surfaces.

1. Water Vapor Permeance: For purposes of conversion, 57.2 ng/(Pa s sq m) = 1 perm.
   a. Vapor Barrier: Has water vapor permeance of 0.1 perms maximum.
   b. Vapor Permeable: Has water vapor permeance of 1 perms or greater.

D. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture resistant, to the degree specified, intended to be installed to shed water without sealed seams.

1.03 REFERENCE STANDARDS

A. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2023a.

B. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.

C. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).

D. ASTM D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method; 1983 (Reapproved 2018).

E. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers; 2022.

F. ASTM E1186 - Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems; 2017.

G. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

H. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies; 2024.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.

K. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work of this section.

B. Product Coordination and Limitations: Provide products that when combined with materials and components of other sections, form exterior wall assemblies as detailed on Drawings, that comply with NFPA 285 testing and acceptance criteria.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product description and data on material characteristics, performance criteria, and limitations.
C. Shop Drawings: For air barrier assemblies.
   1. Show locations and extent of air barrier materials, accessories, and assemblies specific to Project conditions.
   2. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
   3. Include details of interfaces with other materials that form part of air barrier.
D. Product Certificates: From air barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.
E. Qualifications: For manufacturer and applicator.
F. Field Quality Control: Submit field inspection reports.
G. NFPA 285 Documentation: For each product, submit documentation listing compatible materials and components that when used together in wall assemblies as detailed on Drawings, comply with NFPA 285 testing and acceptance criteria.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than 5 years of documented experience.
B. Applicator Qualifications: Company specializing in performing work of the type specified, with minimum 5 years of documented experience and as follows:
   1. Applicator shall be approved or certified by the air barrier manufacturer.
   2. Applicator shall be an accredited installer under the Air Barrier Association of America's (ABAA) Quality Assurance Program.

1.07 MOCK-UP

A. Construct mock-up, 4 feet long by 8 feet wide; include wall construction and typical transition and flashing details at openings such as windows and doors.
   1. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
B. Locate where directed.
C. Mock-up may remain as part of the Work.

1.08 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by the materials manufacturers before, during and after installation.
B. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 PRODUCTS

2.01 MATERIALS

A. Source Limitations: Obtain primary air barrier materials and air barrier accessories from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. Air Barrier Performance: Air barrier assembly and seals with adjacent construction shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

2.03 AIR BARRIER MATERIALS - AIR AND VAPOR BARRIER

A. Air and Vapor Barrier Sheet, Fluid-Applied: Synthetic polymer membrane with an installed dry film thickness, according to manufacturer's written instructions, of 35 mils (0.9 mm) or thicker.
   1. Physical and Performance Properties:
      a. Dry Film Thickness: As recommended by weather barrier manufacturer.
      b. Water Vapor Permeance: 0.1 perms, maximum; ASTM E96/E96M, Method B.
      c. Air Permeance: 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.02 L/sec per sq m, maximum, at 75 Pa); ASTM E2178.
      d. Air Leakage - Assembly: Pass, less than 1 percent; ASTM E2357.
      e. Elongation: 250 percent, minimum; ASTM D412.
      f. Tensile Strength: 100 psi, minimum; ASTM D412.
      g. Flame Spread Index: Less than 25, Class A; ASTM E84.
      h. Smoke Developed Index: Less than 450, Class A; ASTM E84.
      i. Nail Sealability: Pass, no leakage; ASTM D1970/D1970M.
      j. VOC Content: 100 g/L, maximum.
      k. Air barrier shall be an approved component of an NFPA 285 tested exterior wall assembly as detailed on Drawings; tested in accordance with, and complying with the acceptance criteria, of NFPA 285.
   2. Products:
      a. BASF; MasterSeal AWB 660 I: www.master-builders-solutions.basf.us
      b. Carlisle Coatings & Waterproofing; Fire Resist Barritech NP: www.carlisleccw.com.
      c. GCP Applied Technologies; Perm-a-Barrier NPL 10: www.gcpat.com.
      d. Henry Company; Air-Bloc 16MR: www.henry.com.
      e. Prosoco Inc.; R-Guard VB: www.prosoco.com.
      f. Sto Corp.; StoGuard VaporSeal: www.stocorp.com.
      g. Tremco Inc.; EXOAIR 130: www.tremcosealants.com.
      h. W.R. Meadows; Air-Shield LSR: www.wrmeadows.com.
      i. Substitutions: See Section 01 6000 - Product Requirements.

2.04 ACCESSORY MATERIALS

A. Primers: As recommended for substrate by air barrier material manufacturer and accessory manufacturers.

B. Transitions and Flashings:
   1. General:
      a. Products shall be compatible with air barrier and approved by the air barrier manufacturer.
      b. Maintain the continuity of the air and water barrier as it transitions to adjacent materials.
      c. Materials shall be compatible with adjacent materials.
      d. Transisitions and flashings shall be an approved component of an NFPA 285 tested exterior wall assembly as detailed on Drawings; tested in accordance with, and complying with the acceptance criteria of NFPA 285.
   2. Silicone Sheet Transitions:
      a. Pre-cured silicone rubber sheets and pre-molded corners.
      b. Install using liquid-applied flashings and sealants as an adhesive.
      c. Available products include, but are not limited to, the following:
         1) The Dow Chemical Company; Dowsil Silicone Transition Strip: www.dow,com.
         2) Momentive Performance Materials, Inc./GE; UltraSpan UST/USM Pre-Cured Silicone Transition Sheet and Molded Corners: www.siliconeforbuilding.com.
         3) Prosoco Inc.; R-Guard SureSpan EX: www.prosoco.com.
         4) Tremco, Inc.; ProGlaze ETA and Spectrem Simple Seal: www.tremcosealants.com.

3. Flexible Fabric Flashing - Self-Adhering: Self-adhering stainless steel/polymer fabric flashing. ASTM A240/A240M stainless steel sheet bonded with rubber-based adhesive to one sheet of polymer fabric. Flashing shall be self-adhering using a pressure-sensitive adhesive.
   a. Type 304 stainless steel.
      1) Thickness: 2 mils, miniumum.
   b. Available products include, but are not limited to, the following:
      1) York Manufacturing, Inc.; York 304: www.yorkmfg.com.
      2) Momentive Performance Materials, Inc./GE; GE Elemax SS Flashing: www.siliconeforbuilding.com.

C. Sealants: Provide non-sag, single component, silicone sealants compatible with air barrier and approved by the air barrier manufacturer.

D. Miscellaneous Accessories:
   1. As recommended by air barrier manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and conditions are ready to accept the work of this section.
   1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
   2. Verify that substrates have cured and aged for minimum time recommended in writing by air barrier manufacturer.
   3. Verify that substrates are visibly dry and free of moisture. Test concrete substrates for capillary moisture by plastic sheet method according to ASTM D4263.
   4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

B. Mask and protect adjacent surfaces from over spray or dusting.

C. Prepare static gaps and joints as recommended by air barrier manufacturer and as indicated on Drawings.

D. Install transitions and flashings around corners of openings, around penetrations, and elsewhere as recommended by air barrier manufacturer and as indicated on Drawings.
   1. Use silicone sheet transitions and pre-molded corners adhered with liquid-applied flashings and sealants except where flexible fabric flashings or metal flashings are indicated on Drawings or recommended by air barrier manufacturer.

E. Coordinate detailing of transitions to other materials in order to maintain a continuous air and water barrier.
   1. Ensure that transition materials are compatible with adjacent materials and substrates.

F. When recommended by air barrier manufacturer, apply primer in accordance with manufacturer's instructions.

G. Notify Architect of any issues prior to installing air barrier materials. Do not proceed with air barrier installation until issues have been resolved and approved by Architect.

3.03 INSTALLATION

A. Apply primer to substrates as recommended by air barrier manufacturer.

B. Ensure that all transitions, bridging of gaps and joints, corners, flashings, penetrations, and terminations are completed in accordance with the recommendations of the air barrier manufacturer and as indicated on Drawings

C. Apply air barrier material according to air barrier manufacturer's written instructions and details.
   1. Apply continuous unbroken air barrier material to substrates.
   2. Apply air barrier material in full contact around protrusions such as masonry ties.

D. Do not cover air barrier until it has been tested and inspected by testing agency.
E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.
F. Remove masking materials after installation.

3.04 FIELD QUALITY CONTROL

A. Field inspections and tests will be performed by an independent testing agency under provisions of Section 01 4000 - Quality Requirements.
   1. Owner will engage a qualified testing agency to perform tests and inspections.
B. Inspections: Air barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
   1. Verification of substrate preparations. Do not cover until inspections are complete.
   2. Verification that transitions and flashing details are installed properly. Do not cover until inspections are complete.
   3. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
   4. Air barrier dry film thickness.
   5. Site conditions for application temperature and dryness of substrates have been maintained.
   6. Maximum exposure time of materials to UV deterioration has not been exceeded.
   7. Compatible materials have been used.
   8. All penetrations have been sealed.
C. Tests: As determined by testing agency from among the following tests:
   1. Air-Leakage-Location Testing: Air barrier assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers.
   2. Adhesion Testing: Air barrier assemblies will be tested for required adhesion to substrate according to ASTM D4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.
D. Air barriers will be considered defective if they do not pass tests and inspections.
   1. Deficiencies shall be corrected by the Contractor at no additional cost to the Owner.
E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
F. Prepare test and inspection reports.

3.05 PROTECTION

A. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
   1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended by manufacturer.
   2. If exposed to these conditions for longer than recommended, remove and replace overexposed air barrier materials according to air barrier manufacturer's instructions.
B. If damage occurs, patch damaged areas in accordance with air barrier manufacturer's instructions.

END OF SECTION 07 2726

SECTION 07 4213.33 - ALUMINUM COMPOSITE MATERIAL (ACM) SYSTEM

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.02 SUMMARY

A. Definitions:
   1. An Aluminum Composite Material (ACM) Panel System includes ACM panels, joints, attachment system components and miscellaneous materials as appropriate for the design of the project to provide a weather-resistant exterior veneer system.
   2. A “Shop-Fabricated” ACM Panel System is designed with components that permit the complete fabrication in the shop and the subsequent installation of the system in the field.

B. Section Includes:
   1. Exterior installation and performance of ACM panels and ACM Panel System components.

1.03 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed have either been identified by the International Building Code (IBC) or local building code or are specific requirements for this building construction type.

B. Aluminum Association (AA):
   1. Aluminum Design Manual (ADM)
   2. AA-M12C23A31: Anodized – Clear Coating
   3. AA-M12C23A34: Anodized – Color Coating

C. American Architectural Manufacturers Association (AAMA):
   1. AAMA 501.1 Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
   2. AAMA 501.2 Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems
   3. AAMA 508 Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems
   4. AAMA 609 & 610 Cleaning and Maintenance Guide for Architecturally Finished Aluminum
   5. AAMA 2605 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

D. American Society of Civil Engineers (ASCE):
   1. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures

E. ASTM International:
   1. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
   2. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
   3. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
   4. ASTM C645 Standard Specification for Nonstructural Steel Framing Members
   5. ASTM C920 Standard Specification for Elastomeric Joint Sealants
   6. ASTM C1193 Standard Guide for Use of Joint Sealants
   7. ASTM D635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
   8. ASTM D1781 Standard Test Method for Climbing Drum Peel for Adhesives
   9. ASTM D1929 Standard Test Method for Determining Ignition Temperature of Plastics
   10. ASTM D2244 Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

11. ASTM D4214 Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
12. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
13. ASTM E283 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
14. ASTM E330 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls By Uniform Static Air Pressure Difference
15. ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls By Uniform Static Air Pressure Difference
16. ASTM E1233 Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Cyclic Air Pressure Differential

F. National Fire Protection Association (NFPA):
1. NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

1.04 SYSTEM DESCRIPTION

A. Performance Requirements:
1. Provide installed ACM Panel System designed to withstand project-specific design loads while maintaining System Requirements; Deflection and Thermal Movement; and Fire Performance without defects, damage, or failure as defined by the Fabricator and required by this section.

B. System Requirements:
1. Pressure-Equalized Rainscreen (PER) System
a. AAMA 508 Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems
1) ASTM E283 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen – The air flow measurement across the ACM Panel System (excluding jamb conditions) shall not be more than 0.12 cfm per sf of wall area when tested to a pressure difference of 1.57 psf.
2) ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls By Uniform Static Air Pressure Difference – When tested to a pressure difference of 6.24 psf:
(a) All water that penetrates the exterior rainscreen cladding, including condensation, shall be controlled and drained to the exterior.
(b) Water mist or droplets that contact(s) the air/water barrier shall not exceed 5% of the surface.
(c) There shall not be any continuous streaming of water on the air/water barrier surface.
3) AAMA 501.1 Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure – When tested to a pressure difference of 6.24 psf:
(a) All water that penetrates the exterior rainscreen cladding, including condensation, shall be controlled and drained to the exterior.
(b) Water mist or droplets that contact(s) the air/water barrier shall not exceed 5% of the surface.
(c) There shall not be any continuous streaming of water on the air/water barrier surface.
4) ASTM E1233 Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Cyclic Air Pressure Differential – When tested from a positive pressure loading of 5 psf to 25 psf to 5 psf based on a maximum average of 100 three-second cycles:

(a) The lag between the cavity and cyclic wind pressure shall not exceed 0.08 seconds.
(b) The maximum differential between the cavity and cyclic wind pressure shall not exceed 50% of the maximum test pressure.

C. Deflection and Thermal Movement: Provide installed ACM Panel System that has been designed to resist project-specific wind loads, acting both inward and outward:
1. Perimeter Framing Deflection: Deflection of the panel perimeter framing member shall not exceed L/175 normal to plane of the wall, where L is the unsupported span of the perimeter framing member between fastener locations.
2. Panel Deflection: Deflection of the panel face shall not exceed L/60 normal to plane of the wall, where L is the unsupported span of the panel between load transfer locations.
3. At 150% pressure, no permanent deformation exceeding L/1000 or failure to structural members is permitted.
4. Thermal Movements: Allow for free and noiseless horizontal and vertical thermal movement due to expansion and contraction of component parts over a temperature range of -20°F to +180°F at the material surface.
a. Buckling, opening of joints, undue stress on fasteners, failure of sealants, or any other detrimental effects of thermal movement are not permitted.
b. Field-fabrication and installation procedures shall take into account the ambient temperature range at the time of the respective operation.

D. Fire Performance: Wall assemblies containing ACM Panel System shall meet the requirements of NFPA 285 using the Intermediate-Scale Multi-Story Test Apparatus (ISMA), where required by code based on the design of this project.

1.05 SUBMITTALS

A. General: Provide submittals in accordance with Conditions of the Contract and Division 01 Submittal Procedures Section as follows:

B. Product Data: Submit material descriptions, dimensions of individual components and profiles, and finishes for each type of ACM Panel System.

C. ACM Panel System:
1. Submit system-specific design details including, but not limited to, ACM panel, clip, extrusion, stiffener, adhesive, fastener, and sealant components.
2. Submit design data including, but not limited to, material properties, section properties, and capacities for each ACM Panel System component. Design data shall be supported by a qualified Design Professional licensed in the state of primary research and development, design, and manufacturing of the ACM Panel System.
3. Submit system-specific installation guide information.
4. Submit Shop Drawings indicating, but not limited to, elevations and reflected ceiling plans with joint locations and panel sizes; sections with thicknesses and dimensions of components; edge conditions; interfaces with dissimilar materials; corners and transitions; flashings, trims, venting, fasteners, sealants, caulks, and adhesives; accessories; and/or colors.

D. Samples:
1. Selected Samples: Submit Manufacturer’s color charts or chips illustrating full range of colors, finishes, patterns, and textures available for ACM panels with factory-applied finishes. Custom color selection requires color sample to be submitted for approval. Approval signature(s) are required by [Owner] [Architect].
2. Verification Samples:
a. ACM Panel System assembly: Submit 12 inches x 12 inches, or size as required, demonstrating system assembly. Samples to be provided in thickness specified, including ACM panel, molding, clip, adhesive, fastener, and sealant components. Sample need not be provided in the specified color.

b. Submit two samples of each color or finish selected that measure approximately 3 inches x 4 inches, minimum.
c. Custom color samples may contain drawdown lines. Sizes for custom color samples may vary.

E. Quality Assurance Submittals:
1. ACM Material Certification: Submit an official written statement from the Manufacturer documenting that product raw materials meet specified standards. Certification shall be backed by test reports and/or material certificates.
2. ACM Product Certification: Submit an official written statement from the Manufacturer documenting that product complies with specified Performance Requirements indicated in this specification. Certification shall be backed by test reports.
3. ACM Panel System Certification: Submit an official written statement from the Manufacturer documenting that the ACM Panel System complies with specified Performance Requirements indicated in this specification. Certification shall be backed by test reports.

F. Closeout Submittals:
1. Warranty: Submit Manufacturer and Installer warranty documents as specified within the Warranty section of this specification.
2. Maintenance: Submit Manufacturer's recommendations document for Cleaning and Maintenance of the ACM Panel System.

1.06 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer Qualifications: Company with a minimum of 20 years of continuous experience manufacturing ACM panels in the United States of America of the type specified:
a. Able to provide specified warranty on finish.
b. Able to provide a list of other projects of similar size including approximate date of installation for each.
2. Fabricator Qualifications:
a. The Fabricator shall have:
1) Been in business of a similar trade and under the present company name for at least five (5) years prior to the start of this project, and
2) Experience with similar sized ACM Panel System projects, and
3) Fabricated at least three (3) successful projects of the specified ACM Panel System within the last five (5) years
(a) Acceptable, varying combinations of successful projects and/or years of experience shall be determined at the discretion of the Manufacturer.
b. The Fabricator must be capable of providing field service representation during installation.
3. Installer Qualifications:
a. The Installer shall have:
1) Been in business of a similar trade and under the present company name for at least five (5) years prior to the start of this project, and
2) Experience with similar sized ACM Panel System projects, and
3) Installed at least three (3) successful projects of the specified ACM Panel System within the last five (5) years
(a) Acceptable, varying combinations of successful projects and/or years of experience shall be determined at the discretion of the [Manufacturer] [Fabricator].
b. The Installer must be capable of providing field service representation during installation.

B. Regulatory Code Agencies Requirements: Provide ACM Panel System that has been evaluated and is in compliance with the following, where required:

1. International Code Council (ICC)
2. Michigan Building Code.

C. Mock-Ups: Install a mock-up at the project jobsite using acceptable products and Manufacturer-approved details. Obtain Architect's acceptance of finish color (drawdown samples to be used for color approval of nonstandard coil coated colors), texture and pattern, and workmanship standard. Comply with Division 01 Quality Control, Mock-Up Requirements Section.
   1. Mock-Up Size: Provide as detailed in the construction documents if a stand-alone Mock-Up is required.
   2. Maintenance: Maintain mock-up during construction for workmanship comparison; remove and legally dispose of mock-up when no longer required.
   3. Incorporation: Mock-up may be incorporated into final construction upon Owner's approval.

D. Pre-installation Meeting: Conduct pre-installation meeting to verify project requirements, substrate conditions, and system [Manufacturer's] [Fabricator's] installation details.

1.07 DELIVERY AND STORAGE

A. Upon receipt, perform visual inspection of ACM panels and inventory to identify any damages that may have occurred during shipping or any missing panels.

B. Storage:
   1. Store ACM panels horizontally on pallets in a dry, well-ventilated environment under the protection of a temporary or permanent structure. If required to be stored in an exterior area, ACM panels must be placed under a well-ventilated, waterproof covering.
   2. Store ACM panels a minimum of 4" above ground level to avoid contact with standing moisture (e.g. water, snow, etc.).
   3. Store ACM panels in an area protected from other construction activities and associated debris.
   4. Storage temperatures are not to exceed 120°F. Protect ACM panels from moisture and direct sunlight while on the job-site.
   5. Do not stack more than 1500 pounds of ACM panels on one pallet. Other materials shall not be stacked on, or placed in contact with, ACM panels to prevent staining, denting, or other damages.

1.08 PROJECT CONDITIONS

A. Substrate Tolerances: The General Contractor is responsible for providing an acceptable substrate per [Manufacturer's] [Fabricator's] requirements including:
   1. Adjacent substrate faces out-of-plane offset: +/- 1/8 inch, and
   2. Level, plumb, and location control lines as indicated: 1/4 inch in any 20 feet, and
   3. Any building elevation direction deviation: +/- 1/2 inch

B. Field Measurements: Verify locations of wall framing members and wall opening dimensions by field measurements prior to the shop-fabrication of the ACM Panel System. Field measurements to be taken once all substrate materials and adjacent materials are installed.

1.09 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. ACM Manufacturer's Material Warranty: Submit, to the Owner, the Manufacturer's standard warranty.
   1. Warranty Period:
      a. Material and Product Integrity: Five (5) years against delamination at any manufactured bond line
      b. Coil-Coated PVDF/Kynar 500 Painted Finish: Thirty (30) years against:
         1) Chalking in excess of a numerical rating of eight (8) when measured in accordance with ASTM D4214, Method A

2) Fading or change color in excess of five (5) E units (NBS) when calculated in accordance with ASTM D2244, paragraph 6.3
3) Cracking, chipping, splitting, blistering, peeling, or loss of adhesion. Minute fracturing (i.e. crazing or cracking) as a result of routing and bending of the ACM panels shall be excluded.

C. Shop-Fabrication Warranty: Fabricator shall submit to the Owner a standard warranty document executed by an authorized company official. The warranty shall be in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.
1. Warranty Period:
a. Workmanship: One (1) year warranty period commencing on Date of Substantial Completion.

D. Installation Warranty: Installer shall submit to the Owner a standard warranty document executed by an authorized company official. The warranty shall be in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.
1. Warranty Period:
a. Workmanship: One (1) year warranty period commencing on Date of Substantial Completion.

PART 2 – PRODUCTS

2.01 ACM MANUFACTURERS AND SHOP-FABRICATED ACM PANEL SYSTEM SUPPLIERS

A. ACM Manufacturers:
1. Omega-Lite panels manufactured by Laminators Inc. – www.laminatorsinc.com

B. Shop-Fabricated ACM Panel System Suppliers:
1. Laminators Inc. – www.laminatorsinc.com

2.02 ALUMINUM COMPOSITE MATERIAL (ACM)

A. ACM Panel Description
1. Construction:
a. Two sheets of aluminum bonded to a core of extruded thermoplastic manufactured in a laminated batch (i.e. discontinuous) process using adhesive(s) between dissimilar materials. The core material shall not contain foam plastic insulation.
2. Thickness: 0.157 inch (4 mm)
3. Sheets:
a. Face Thickness: 0.020 inch nominal or thicker
b. Backer Thickness: 0.0125 inch nominal or thicker
c. Combined Minimum Thickness: 0.0365 inch nominal (Face + Backer)
4. Product:
a. On Types I, II, III, and IV Construction to any height above grade in accordance with the provisions of IBC Section 1407.10.
5. Fire Performance: Class A Material
a. ASTM E84: ACM panels shall have a Flame Spread Index (FSI) of not more than 25 when tested in the maximum thickness intended for use.
b. ASTM E84: ACM panels shall have a Smoke Developed Index (SDI) of not more than 450 when tested in the maximum thickness intended for use.
6. Bond Integrity:
a. ASTM D1781 Climbing Drum Peel Strength: 22.5 in-lb/in minimum as manufactured
b. Chemically-bonded to the core material in a laminated batch process

2.03 FINISH

A. Exterior Finish: Finish shall meet the performance criteria of AAMA 2605.
1. Custom Finish:
a. Selected by the **Architect** and coordinated with Manufacturer

2.04 SYSTEM COMPONENTS

A. General: Provide Manufacturer's standard ACM Panel System-specific components, including, but not limited to, mountings, adhesives, connections, and fasteners for specific applications indicated on contract documents.

2.05 RELATED MATERIALS

A. General: Refer to Related Sections specified herein for other materials, including concrete, masonry, framing, sheathing, barriers, flashing and trim, sealants, windows, glazing, and/or curtain walls.

2.06 SHOP-FABRICATION

A. General:
   1. Fabricate panels to sizes and joint configurations indicated on approved Shop Drawings based on an assumed design temperature of 70°F. Allow for ambient temperature range at time of fabrication.
   2. Fabricate panels with sharply cut edges and no displacement of face or backer sheets or protrusion of core. Form panel angles, breaks, corners, lines, and returns to be sharp, true, and free of buckle and/or warp.

B. Fabrication Tolerances:
   1. Width: +/- 1/16- inch @ 70°F
   2. Length: +/- 1/16 inch @ 70°F
   3. Squareness: +/- 1/16 inch @ 70°F

C. System Type:
   1. A Pressure-Equalized Rainscreen (PER) system shall allow air to quickly pass through panel joints while minimizing and controlling water infiltration at the air/water barrier. The system must be properly compartmentalized to prevent internal cavity air from moving between different pressure zones of the building surfaces. The system shall be tested per AAMA 508.

D. System Components:
   1. Panel perimeter components shall be extruded or formed aluminum as indicated on system-specific design details to meet the Performance Requirements according to Fabricator's design. Galvanized cold-formed steel clips or staggered aluminum angles are not acceptable for panel to panel attachment.

PART 3 – EXECUTION

3.01 INSTALLER INSTRUCTIONS

A. Compliance: Comply with Manufacturer's product data, including, but not limited to, installation guides, design details, product technical bulletins, supplemental technical instructions, and any other product packaging instructions.

3.02 PREPARATION

A. Site Verification of Conditions: Verify that conditions of substrate previously installed under other sections are acceptable for the ACM Panel System installation. Documentation should be provided to the Architect indicating any conditions detrimental to the performance of the ACM Panel System.

B. Field measurements of site conditions shall be verified with approved Shop Drawings prior to beginning of installation. Notification of any product modifications and resulting schedule adjustment shall be documented to the Architect.

3.03 INSTALLATION

A. General:
   1. Handling:
      a. Protective masking should be left on the field of each ACM panel during installation to minimize potential damages from construction activities. Note that all masking must be removed within 2 weeks of installation.

b. Handle ACM panels with clean work gloves to avoid hand injury from any sharp edges and to prevent staining of surfaces with contaminants.
c. Glazing suction cups are recommended to handle ACM panels whenever possible.

2. Install the ACM Panel System plumb, level, and true in accordance with Manufacturer's Installation Requirements and approved Shop Drawings.
3. Comply with Manufacturer's instructions for installation of concealed fasteners; provisions of Section 079200; and recommendations for installation of joint sealants.
4. Panel stiffeners shall be extruded or formed aluminum or cold-formed steel as indicated on system-specific design details to meet the Performance Requirements according to the Fabricator's design. Unless required during shop-fabrication, stiffeners shall be mechanically fastened to the substrate and secured to the rear face of ACM panels with adhesive of sufficient size and strength.
5. Installation Tolerances:
   a. Adjacent vertical or horizontal panel out-of-plane offset: +/- 1/16 inch
   b. Vertical or horizontal joint width: +/- 1/16 inch
   c. Adjacent vertical or horizontal panel edge alignment: +/- 1/16 inch
   d. Adjacent vertical or horizontal joint deviation: +/- 1/16 inch
   e. Maximum vertical or horizontal joint deviation: 1/4 inch in any 20 feet
6. Do not cut, trim, weld, or braze ACM Panel System-specific components during installation in a manner which would damage the finish, decrease strength, or result in visual imperfection or a failure in performance.
7. Separate contact of dissimilar metals with approved methods as defined by the Manufacturer in order to eliminate the possibility of corrosive or electrolytic action between metals.

B. Related Products Installation Requirements: Refer to other sections in Related Sections for installation of related products.

3.04 FIELD QUALITY REQUIREMENTS

A. Field Quality Control: When required, mock-up shall be constructed and tested at the direction of the Architect. Water-spray testing on the mock-up of the ACM Panel System shall be in accordance with AAMA 501.2.
B. Testing Agency: If required, the Architect shall engage a qualified testing agency to perform tests and inspections.

3.05 REMEDIATION AND CLEANING

A. Remediation:
1. Remove and replace ACM Panel System-specific components damaged as a direct result of activities in the Panel Installation section.
2. Remove protective masking immediately after installation of ACM Panel System. Masking intentionally left in place after Panel Installation on an elevation at the direction of the Construction Manager shall become the responsibility of the Contractor.
3. Following Panel Installation completion, any determination of repair or replacement of ACM Panel System-specific components is at the discretion of the Architect. Such repair or replacement shall become the responsibility of the Contractor.
   a. At the discretion of the Architect, repair damaged ACM Panel System-specific components such that repairs are not discernible at a distance of 10 feet from the surface at a 90° angle per AAMA 2605.
4. Removal and replacement of ACM Panel System-specific components damaged by other trades shall be the responsibility of the Construction Manager.
5. If required after Panel Installation, any additional protection of the ACM Panel System shall be the responsibility of the Construction Manager.
6. Remove from project site damaged ACM Panel System-specific components, protective masking, and other debris attributable to work of this section.

B. Cleaning:

1. Final Cleaning shall not be part of the work of this section.
2. Cleaning and Maintenance of the BD&V ACM Panel System shall be performed at least once a year in accordance with AAMA 609 & 610.

END OF SECTION 07 4213.33

SECTION 07 5323 - EPDM MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ethylene-propylene-diene-terpolymer (EPDM) roofing assembly; fully adhered. Including, but not limited to, the following:
   1. Cover board.
   2. Insulation, flat and tapered.
   3. Vapor barrier.
   4. Substrate board.
   5. Walkway pads.

1.02 ABBREVIATIONS

A. EPDM: Ethylene-propylene-diene-terpolymer.

1.03 REFERENCE STANDARDS

A. ASTM C1278/C1278M - Standard Specification for Fiber-Reinforced Gypsum Panel; 2017.
B. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.
C. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2023a.
D. ASTM D1876 - Standard Test Method for Peel Resistance of Adhesives (T-Peel Test); 2008 (Reapproved 2023).
E. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.
F. ASTM D5602/D5602M - Standard Test Method for Static Puncture Resistance of Roofing Membrane Specimens; 2018 (Reapproved 2022).
G. ASTM D4637/D4637M - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane; 2015, with Editorial Revision (2022).
H. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds; 1998 (Reapproved 2017).
I. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.
J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.
K. FM (AG) - FM Approval Guide; Current Edition.
L. FM 4470 - Examination Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction; 2022.
M. FM DS 1-28 - Wind Design; 2015, with Editorial Revision (2024).
N. FM DS 1-29 - Roof Deck Securement and Above-Deck Roof Components; 2016, with Editorial Revision (2022).
O. FM DS 1-49 - Perimeter Flashing; 2016.
P. NRCA (RM) - The NRCA Roofing Manual; 2023.
Q. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of associated counterflashings installed under other sections.
B. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all affected installers; review preparation and installation procedures and coordination and scheduling necessary for related work.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating membrane materials, flashing materials, cover boards, insulation, vapor barrier, substrate board, adhesives, and fasteners.
C. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, setting plan for tapered insulation, walkway pad locations, and sacrificial membrane locations.
D. Samples for Verification: Submit three samples 4 by 4 inches in size illustrating roofing membrane, cover board, insulation, vapor barrier, substrate board, and walkway pads.
E. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.
F. Manufacturer's Qualification Statement.
G. Installer's Qualification Statement.
H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
I. Field Quality Control Reports.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience, and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
B. Store products in weather protected environment, clear of ground and moisture.
C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.
D. Protect foam insulation from direct exposure to sunlight.
E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.08 FIELD CONDITIONS

A. Do not install roofing assembly during unsuitable weather and temperatures as defined by roofing membrane manufacturer.
B. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer Warranty: Provide 20 year manufacturer's system warranty where manufacturer shall repair or replace roofing system components that fail in materials or workmanship; includes failure to prevent penetration of water to include rood edge metals.
C. Installer Warranty: Provide installation warranty where Installer agrees to correct defective Work within a 2 year period after Date of Substantial Completion; includes failure to prevent penetration of water.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Roof Assembly shall be provided by by one of the following:
1. Carlisle SynTec Systems; www.carlislesyntec.com.
2. Holcim Elevate (formerly Firestone Building Products); www.holcimelevate.com.

3. Johns Manville; www.jm.com.
4. Substitutions: Not permitted.

B. Source Limitations: Obtain roof membrane from one of the named Roof Assembly manufacturers and provide related roofing assembly components from either the roof membrane manufacturer or one of the listed product manufacturers; subject to approval of roof membrane manufacturer.

2.02 ROOFING ASSEMBLY

A. Single-ply membrane roofing assembly consisting of the following:
1. EPDM single-ply roof membrane; fully adhered.
2. Cover board; fully adhered.
3. Insulation, including tapered insulation; first layer mechanically fastened, all subsequent layers fully adhered.
4. Vapor barrier.
5. Substrate board; mechanically fastened.
6. Walkway pads.

B. Performance Requirements:
1. Comply with Factory Mutual (FM) Global and FM Approvals' RoofNav Listing requirements as follows:
a. Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals FM 4450 or FM Approvals FM 4470 as part of a roofing system, and shall be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
1) Fire/Windstorm Classification: Class 1A-90.
2) Hail-Resistance Rating: SH.
b. Comply with the following Property Loss Prevention Data Sheets:
1) Data Sheet FM DS 1-28: Wind Design.
2) Data Sheet FM DS 1-29: Roof Deck Securement and Above-Deck Roof Components.
3) Data Sheet FM DS 1-49: Perimeter Flashing.
2. Minimum Insulation Requirements: Excluding tapered insulation.
a. Minimum Layers of Insulation: Two.
b. Minimum R-value: 30.
3. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials as demonstrated by roof membrane manufacturer based on testing and field experience.

2.03 ROOF MEMBRANE

A. Membrane: Ethylene-propylene-diene-terpolymer (EPDM); internally reinforced with fabric or scrim; complying with minimum properties of ASTM D4637/D4637M.
1. Thickness: 0.060 inch (60 mil), nominal.
2. Color: Black.

2.04 COVER BOARD

A. Faced Polyisocyanurate Cover Board: High compressive strength board, conforming to ASTM C1289, Type II, Class 4 - Faced with coated or uncoated polymer-bonded glass fiber mat facers on both major surfaces of the core foam.
1. Grade and Compressive Strength: Grade 1, 80 psi.
2. Board Size: 4 by 4, or 4 by 8 feet.
3. Board Thickness: 1/2 inch.
4. Insulation Thermal Resistance, R-value: 2.5, nominal.
5. Products:
a. Carlisle SynTec Systems; SecurShield HD Plus: www.carlislesyntec.com.
b. Holcim Elevate (formerly Firestone Building Products); ISOGARD HD Cover Board: www.holcimelevate.com.

c. Johns Manville; ProtectoR HD: www.jm.com.
d. Substitutions: See Section 01 6000 - Product Requirements.

2.05 INSULATION

A. Polyisocyanurate Board Insulation: Rigid cellular foam, conforming to ASTM C1289.
1. Classifications:
a. Type II:
1) Class 2 - Faced with coated polymer-bonded glass fiber mat facers on both major surfaces of core foam.
2) Compressive Strength: Grade 2 - 20 psi (138 kPa), minimum.
3) Long Term Thermal Resistance (LTTR) R-value: At 1 inch thick; 5.7 at 75 degrees F.
2. Board Size: 4 by 4, or 4 by 8 feet.
3. Board Thickness: 2.0 inch.
4. Tapered Board: Slope as indicated; minimum thickness 1/2 inch; fabricate of fewest layers possible.
5. Board Edges: Square.
6. Products:
a. Carlisle SynTec Systems; SecurShield: www.carlislesyntec.com.
b. Holcim Elevate (formerly Firestone Building Products); Resista: www.holcimelevate.com.
c. Johns Manville; Enrgy 3 CGF:www.jm.com.
d. Substitutions: See Section 01 6000 - Product Requirements.

2.06 VAPOR BARRIER

A. Self-Adhering-Sheet Vapor Barrier: Polyethylene film laminated to layer of butyl rubber adhesive; cold applied, with slip-resisting surface and release paper backing.
1. Properties:
a. Thickness: 30 mil total thickness, minimum; ASTM D1970/D1970M.
b. Tensile Strength: 50 lbf/in MD, 70 lbf/in XMD; ASTM D5147.
c. Elongation: 50 percent MD, 20 percent XMD; ASTM D5147; 73 degress F.
d. Low Temperature Flexibility: Minus 30 degress F; ASTM D5147.
e. Static Puncture: 90 lbf; ASTM D5602/D5602M.
f. Tear Strength: 80 lbf/in MD, 90 lbf/in XMD; ASTM D5601; at 73 degress F.
g. Lap Adhesion: 6 lbf/in; ASTM D1876; at 73 degress F
h. Peel Resistance: 5 lbf/in; ASTM D903.
i. Water Absorption: Less than 0.1 percent; ASTM D5147.
j. Water Vapor Permeability: Maximum permeance rating of 0.1 perm; ASTM E96/E96M, Procedure B.
k. Air Permeability: Maximum permeance of 0.0002 cu ft/min-sq ft; ASTM E2178.
2. Products:
a. Carlisle SynTec Systems; VapAir Seal 725TR: www.carlislesyntec.com.
b. Holcim Elevate (formerly Firestone Building Products); V-Force: www.holcimelevate.com.
c. Johns Manville; JM Vapor Barrier SA: www.jm.com.
d. Substitutions: See Section 01 6000 - Product Requirements.

2.07 SUBSTRATE BOARD

A. Substrate Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M, fiber-reinforced gypsum board.
1. Thickness: 1/2 inch.
2. Size: 4 by 4, or 4 by 8 feet.
3. Products:
a. Georgia-Pacific Gypsum: DensDeck Prime Roof Board: www.gp.com.
b. National Gypsum Company; DEXcell Brand FA Glass Mat Roof Board: www.nationalgypsum.com.

c. United States Gypsum Co.; USG Securock Brand Gypsum-Fiber Roof Board; www.usg.com.
d. Substitutions: See Section 01 6000 - Product Requirements.

2.08 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads.
1. Size: 30 by 30 inches.
2. Thickness: 0.30 inch, minimum.
3. Color: Black.
4. Products:
a. Carlisle SynTec Systems; Sure-Seal EPDM Pressure-Sensitive Molded Walkway Pads: www.carlislesyntec.com.
b. Holcim Elevate (formerly Firestone Building Products); QuickSeam Walkway Pad: www.holcimelevate.com.
c. Johns Manville; JM EPDM Peel & Stick Walkpads: www.jm.com.
d. Substitutions: See Section 01 6000 - Product Requirements.

2.09 ACCESSORIES

A. Auxiliary Materials: Provide all materials recommended by roofing assembly manufacturer for a complete and weathertight assembly.
B. Flexible Flashing Material: Same material as roofing membrane.
1. Thickness: Same as roofing membrane unless otherwise recommended by roof membrane manufacturer.
2. Uncured, unless otherwise recommended by roof membrane manufacturer.
C. Factory Fabricated Flashings: Same material as roofing membrane
1. Provide manufacturer's standard preformed flashings including, but not limited to, cone and vent sheet flashings, molded pipe boot flashings, and pourable sealer penetration pockets.
D. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel bars, approximately 1 by 1/8 inch thick; with anchors.
E. Membrane and Flashing Adhesive: As recommended by membrane manufacturer.
F. Seaming Materials: Manufacturer's standard splice tape with release film.
G. Insulation Adhesive: As recommended by insulation manufacturer and as follows:
1. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals FM 4470, designed for fastening components to substrate, and acceptable to roofing system manufacturer
I. Sealants and Pourable Sealers: As recommended by membrane manufacturer.
J. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
K. Vapor Barrier Primer: As recommended by vapor barrier manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.
B. Verify deck is supported and secure.
C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
D. Verify deck surfaces are dry and free of snow or ice.
E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and nailing strips are in place.

3.02 INSTALLATION - GENERAL

A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.

B. Do not apply roofing membrane during unsuitable weather.
C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.03 SUBSTRATE BOARD INSTALLATION

A. Install substrate boards with long joints in continuous straight lines and end joints staggered not less than 24 inches on center between board rows.
B. At metal deck, install substrate board at right angle to flutes of deck.
   1. Locate end joints over crests of metal deck.
C. Tightly butt substrate boards together.
D. Cut substrate board to fit tight around penetrations and projections.
E. Fasten substrate board to top flanges of metal deck according to roof assembly manufacturer's instructions and FM (AG) Factory Mutual requirements.

3.04 VAPOR BARRIER INSTALLATION

A. Self-Adhering-Sheet Vapor Barrier: Install according to vapor barrier manufacturer's instructions. Prime substrate if required by manufacturer. Lap self-adhering-sheet vapor barrier sides and ends a minimum of 3 and 6 inches, respectively.
B. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
C. Completely seal vapor barrier at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.05 INSULATION INSTALLATION

A. Ensure vapor barrier is clean and dry, continuous, and ready for application of insulation.
B. Attachment of Insulation: Includes tappered insulation.
   1. Mechanically fasten first layer of insulation to deck in accordance with roof assembly manufacturer's instructions and FM (AG) Factory Mutual requirements.
   2. Embed each subsequent layer of insulation in adhesive in accordance with roof assembly manufacturers' instructions and FM (AG) Factory Mutual requirements.
   3. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.
C. Cover Boards:
   1. Adhere cover board to insulation using adhesive according to roof assembly manufacturer's instructions and FM (AG) Factory Mutual requirements.
D. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
E. On metal deck, place boards perpendicular to flutes with insulation board ends bearing on deck flutes.
F. Lay boards with edges in tight contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
   1. Gaps between boards and adjacent materials shall not exceed 1/4 inch.
G. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 24 inches.
H. Do not apply more insulation than can be covered with membrane in same day.

3.06 MEMBRANE INSTALLATION

A. Fully adhere membrane roofing system in accordance with manufacturer's recommendations and NRCA (RM) applicable requirements.

B. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
C. Shingle joints on sloped substrate in direction of drainage.
D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
   1. Overlap edges and ends and seal seams by splice tape. Seal permanently waterproof.
E. At intersections with vertical surfaces:
   1. Fully adhere flexible flashing over membrane and up to nailing strips.
   2. Secure flashing to nailing strips at 4 inches on center.
F. At gravel stops, extend membrane under gravel stop and down face of wall behind gravel stop fascia. Secure with fasteners to nailing strips.
G. At copings, unless otherwise indicated, extend membrane under coping and down face of wall behind front of coping. Secure with fasteners to nailing strips.
H. Around roof penetrations, seal flanges and flashings with flexible flashing.
I. Install roofing expansion joints where indicated. Make joints watertight.
   1. Install prefabricated joint components in accordance with manufacturer's instructions.
J. Coordinate installation of roof drains and sumps and related flashings.
K. Coordinate installation of associated counterflashings installed under other sections.

3.07 SACRIFICIAL MEMBRANE INSTALLATION

A. At roof exhausts which expel vegetable oils, animal fats, and other kitchen wastes, or expel other chemicals detrimental to the roof membrane, install a sacrificial membrane over the roof membrane in an 8 foot radius, minimum, around the roof exhaust.
   1. Sacrificial membrane shall be the same material and thickness as the roof membrane.

3.08 WALKWAY PAD INSTALLATION

A. Walkway Pads: Install walkway products according to manufacturer's instructions.
B. Install walkway pads at the following locations:
   1. Perimeter of each rooftop unit.
   2. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
   3. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
   4. Top and bottom of each roof access ladder.
   5. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
   6. At downspout discharges onto roof assembly.
   7. Other locations as indicated on Drawings.
   8. As required by roof membrane manufacturer's warranty requirements.
C. Provide 6 inch clearance between adjoining pads.
D. Adhere walkway products to substrate with compatible adhesive according to walkway pad manufacturer's instructions.

3.09 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for field quality control and inspection.
B. Require site attendance of roof assembly manufacturer daily during installation of the Work.
C. Final Roof Inspection: Arrange for roof assembly manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements

3.10 CLEANING

A. Clean all dirt, footprints, overspray, spillage, debris, and other construction waste materials from the roof assembly.

B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.

C. Repair or replace defaced or damaged finishes caused by work of this section.

3.11 PROTECTION

A. Protect installed roofing and flashings from construction operations.

END OF SECTION 07 5323

SECTION 07 6200 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Formed sheet metal items, including, but not limited to, the following:
   1. Flashings.
   2. Counterflashings.
   3. Drip edges.
   4. Gutters and downspouts.
   5. Precast splash blocks.
   6. Other items as indicated on Drawings.

B. Manufactured reglets.

1.02 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

B. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.

C. ASTM B32 - Standard Specification for Solder Metal; 2020.

D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

E. FM DS 1-49 - FM Global Property Loss Prevention Data Sheet - Perimeter Flashing; 2016.

F. NRCA (RM) - The NRCA Roofing Manual; 2023.

G. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

C. Samples:
   1. For each material and finish, submit three samples 4 by 4 inch in size illustrating metal finish color.
   2. Reglets: Submit three samples, 4 inches long, full size, of each type and finish.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA (ASMM) requirements, except as otherwise indicated.

B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 5 years of documented experience.

1.06 MOCK-UP

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
   1. Build mockup of typical wall flashing with counterflashing, approximately 10 feet long, including supporting construction cleats, seams, attachments and accessories.
   2. Locate where directed.
   3. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Perform work in accordance with SMACNA (ASMM) and NRCA (RM) requirements, unless more stringent requirements are indicated.
B. Sheet metal flashing and trim shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction.
C. Sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
D. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standards, and by Data Sheet FM DS 1-49: Perimeter Flashing, for application, but not less than thickness of metal being secured.
E. Coordination:
    1. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
    2. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

2.02 SHEET MATERIALS

A. Pre-Finished Aluminum: ASTM B209 (ASTM B209M); 20 gage, (0.032 inch) thick, minimum; plain finish shop pre-coated with fluoropolymer coating.
    1. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
    2. Color: Two or three-coat custom color to match Architect's sample.
B. Stainless Steel: ASTM A666/A666M, Type 304 alloy, soft temper, 24 gage, 0.025 inch thick, minimum; smooth 2D (dull, cold rolled) finish.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
B. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes.
C. Fabricate cleats of same material as sheet, interlocking with sheet.
D. Form pieces in longest possible lengths.
E. Hem exposed edges on underside 1/2 inch; miter and seam corners.
F. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
G. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
H. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

2.04 GUTTER AND DOWNSPOUT FABRICATION

A. Material: Pre-finished aluminum.
B. Gutters: SMACNA (ASMM) Rectangular profile; matching Style A.
    1. Expansion Joints: Lap type.
C. Downspouts: Rectangular profile.
D. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM), unless otherwise indicated.
E. Anchorage Accessories: Profiled to suit gutters and downspouts.
    1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
    2. Gutter Supports: Continuous cleat and straps.
    3. Downspout Supports: Straps.
F. Downspout Boots: Plastic, unless otherwise indicated.
G. Seal metal joints.
H. Accessories:

1. Continuous, removable leaf screen; sheet metal frame and hardware cloth screen.
2. Valley baffles.

2.05 ACCESSORIES

A. General: Provide all related materials, fasteners, hardware and accessories for a complete installation.

B. Fasteners: Same material and finish as flashing metal, with soft neoprene washers.
1. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
2. Exposed Fasteners: Heads matching color of sheet metal using factory-applied coating.

C. Protective Backing Paint: Zinc molybdate alkyd.

D. Concealed Sealants: Non-curing butyl sealant.

E. Exposed Sealants: ASTM C920; elastomeric silicone sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.

F. Solder: ASTM B32; Sn96 type for stainless steel.

2.06 DRIP EDGES

A. Material: Pre-finished aluminum.

B. Provide L-shaped drip edges; extend horizontal leg 4 inches onto roof with vertical leg terminated with a 45 degree bent drip edge.

C. At Contractor's option, provide manufactured drip edges of type and profile required.

2.07 REGLETS

A. Manufactured Reglets: Units of type and profile required, formed to securely interlock with separate counterflashing pieces. Provide factory-mitered and welded corners and junctions.
1. Material: Same material and finish as counterflashing metal.
2. Surface Mounted Type: Provide slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
3. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
4. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
5. Accessories:
   a. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge
6. Manufacturers:
   a. Cheney Flashing Company: www.cheneyflashing.com.
   b. Fry Reglet Corporation: www.fryreglet.com.
   c. Heckmann Building Products, Inc.: www.heckmannbuildingprods.com.
   d. Hohmann & Barnard, Inc.: www.h-b.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.

2.08 PRECAST CONCRETE SPLASH BLOCKS

A. Precast Concrete Splash Block:
1. Size: Approximately 12 inches wide by 30 inches long by 4 inches deep.
2. Color: Gray.
3. Weight: Approximately 50 pounds.
4. Manufacturers: Available manufacturer's include, but are not limited to, the following:
   a. The Century Group: www.centurygrp.com.
   b. Modern Pre-Cast, Inc.: www.modernprecast.com.
   c. NuCast Precast Company: www.nucastprecast.com.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.
B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
C. To prevent galvanic action or corrosion, back paint concealed metal surfaces with protective backing paint, minimum dry film thickness of 3 mil, where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates.

3.03 INSTALLATION - GENERAL

A. Install flashings and trim in accordance with SMACNA (ASMM) and NRCA (RM) requirements, unless more stringent methods are indicated.
B. Unless otherwise indicated, provide pre-finished aluminum flashings and trim in areas exposed to public view; at all other areas provide stainless steel flashings.
C. Insert flashings into reglets to form tight fit; secure in place with plastic wedges; seal flashings into reglets with sealant.
    1. Counterflashings shall lap base flashing 4 inches, minimum.
D. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
E. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
F. Seal metal joints watertight.
G. For stainless steel, solder metal joints for full metal surface contact, and after soldering wash metal clean with neutralizing solution and rinse with water.
    1. Do not solder aluminum.

3.04 GUTTERS AND DOWNSPOUTS

A. Secure gutters and downspouts in place with concealed fasteners.
    1. Gutter Supports: Space 30 inches on center, maximum.
    2. Downspout Supports: Locate at top and bottom of downspout and 60 inches on center, maximum.
B. Slope gutters 1/4 inch per 10 feet, minimum, unless otherwise indicated.
C. Where indicated, connect downspouts to downspout boots, and seal connection watertight.
D. Where gutters spill on grade, provide precast concrete splash block at each downspout discharge.

3.05 DRIP EDGES

A. Install at bottom edges of roof slopes, roof rakes, and elsewhere as indicated.
B. Fasteners: Space 18 inches on center, maximum.

3.06 REGLETS

A. Surface Mounted Type: Install according to manufacturer's instructions.
B. Refer to Section 03 3000 - Cast-in-Place Concrete, for casting reglets in concrete.
C. Refer to Section 04 2000 - Unit Masonry, for embedding reglets in masonry.

3.07 TOLERANCES

A. Sheet Metal Flashing and Trim Tolerances:
    1. Install to tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings.
    2. Install with 1/8 inch maximum offset of adjoining faces and of alignment of matching profiles.

3.08 CLEANING

A. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal manufacturer. Maintain sheet metal flashing and trim in clean condition.

B. Replace sheet metal flashing and trim damaged or deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 6200

SECTION 07 7100 - ROOF SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured roof specialties, including:
   1. Copings.
   2. Fascia/gravel stops.
   3. Roof expansion joint cover assemblies.
   4. Gutters and downspouts.

1.02 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
B. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems; 2022.
C. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement; 2025.
D. NRCA (RM) - The NRCA Roofing Manual; 2023.
E. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on shape of components, materials and finishes, anchor types and locations.
C. Shop Drawings: Indicate configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected work.
D. Samples:
   1. For each material and finish, submit three samples 4 by 4 inch inch in size illustrating metal finish color.
   2. Provide a full size sample, 12 inches long, for each of the following:
      a. Copings.
      b. Roof edges/gravel stops.
      c. Roof expansion joint cover assemblies.
      d. Gutters and downspouts.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.
B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Copings: Factory fabricated to sizes required; corners mitered; concealed fasteners.
   1. Configuration: Concealed continuous hold down cleat at both legs; internal splice piece at joints of same material, thickness, and finish as cap; concealed stainless steel fasteners.
   2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-3 to positive and negative design wind pressure as defined by applicable local building code.
   3. Material: Formed aluminum sheet, 0.063 inch thick, minimum.
   4. Finish: PVDF coating; 70 percent polyvinylidene fluoride.
   5. Color: Two or three coat custom color to match Architect's sample.
   6. Products:
      a. Architectural Products Co.; AP Snap Tight Coping: www.archprod.com.
      b. ATAS International, Inc.; Rapid-Lok Coping: www.atas.com.
      c. Carlisle SynTec Systems; SecureEdge 200 Coping: www.carlislesyntec.com.
      d. Firestone Building Products; Firestone Gold Coping: www.firestonebpco.com.
      e. Johns Manville; Presto Lock Coping System: www.jm.com.

f. Metal-Era; Perma-Tite Coping: www.metalera.com.
g. OMG Roofing Products; PermaSnap: www.omgroofing.com.
h. Petersen Aluminum Corp.; PAC-TITE Coping: www.pac-clad.com.
i. Sika Sarnafil; Wall Grip Coping: usa.sarnafil.sika.com.
j. Substitutions: See Section 01 6000 - Product Requirements.

B. Fascia/Gravel Stop: Factory fabricated to sizes required; mitered, welded corners; concealed fasteners.
1. Configuration: Fascia, cant, and edge securement for roof membrane.
2. Accessories:
a. Fascia extenders with continuous hold-down cleats.
1) Depth: As indicated on Drawings.
3. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test methods RE-1 and RE-2 to positive and negative design wind pressure as defined by applicable local building code.
4. Material: Formed aluminum sheet, 0.050 inch thick, minimum.
5. Finish: PVDF coating; 70 percent polyvinylidene fluoride.
6. Color: Two or three coat custom color to match Architect's sample.
7. Products:
a. Architectural Products Co.; AP Snap-On Fascia: www.archprod.com.
b. ATAS International, Inc.; Edge-Lok 2: www.atas.com.
c. Carlisle SynTec Systems; SecureEdge 200 Fascia: www.carlislesyntec.com.
d. Firestone Building Products; Firestone EdgeGard - Snap-On: www.firestonebpco.com.
e. Johns Manville; Presto-Tite Edge One Fascia System: www.jm.com.
f. Metal-Era; Perma-Tite System 200 Fascia: www.metalera.com.
g. OMG Roofing Products; EconoSnap Fascia System: www.omgroofing.com.
h. Petersen Aluminum Corp.; PAC Snap Edge Fascia: www.pac-clad.com.
i. Sika Sarnafil; Edge Grip Fascia: usa.sarnafil.sika.com.
j. Substitutions: See Section 01 6000 - Product Requirements.

C. Expansion Joint Covers - Bellows: Composite construction of flexible EPDM or neoprene flashing of black color with closed cell urethane foam backing, each edge seamed to stainless steel sheet metal flanges, designed for nominal joint width of 2 inch. Include special formed corners, tees, intersections, and wall flashings, each sealed watertight.
1. Type: Roof-to-roof and roof-to-wall; cant based.
2. Accessories: Include the following:
a. Manufacturer's standard moisture barrier.
3. Products:
a. Balco, Inc.; BRB-WC Series: www.balcousa.com.
b. Construction Specialties, Inc.; BRJW-CF Series: www.c-sgroup.com.
c. Johns Manville; Expand-O-Flash CF/EJ Series: www.jm.com.
d. MM Systems Corp.; ERFL Series: www.mmsystemscorp.com.
e. Inpro Corporation; 674-G02 Series: www.inprocorp.com.
f. Nystrom; ECFw Series: www.nystrom.com.
g. Watson Bowman Acme Corp.; Wabo Flash EEJ/C Series: www.wbacorp.com.
h. Substitutions: See Section 01 6000 - Product Requirements.

D. Gutters and Downspouts: Factory fabricated gutters and downspouts.
1. Gutters: SMACNA rectangular style profile.
2. Downspouts: SMACNA Rectangular profile.
3. Material: Formed aluminum sheet, 0.063 inch thick, minimum.
4. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM), unless otherwise indicated.
5. Anchors and Supports: Profiled to suit gutters and downspouts.
a. Anchoring Devices: Type recommended by fabricator, but not less than SMACNA requirements.

b. Gutter Supports: Brackets.
c. Downspout Supports: Brackets.

6. Downspout Boots: Plastic, unless otherwise indicated.
7. Finish: PVDF coating; 70 percent polyvinylidene fluoride.
8. Color: Two or three coat custom color to match Architect's sample.
9. Manufacturers:
   a. Architectural Products Co.; www.archprod.com.
   b. ATAS International, Inc.; www.atas.com.
   c. Metal-Era; www.metalera.com.
   d. OMG Roofing Products; www.omgroofing.com.
   e. Southern Aluminum Finishing Co, Inc.(SAF); www.saf.com <http://www.saf.com>.
   f. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FINISHES

A. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system. Two or three-coat system, unless otherwise indicated.

2.03 ACCESSORIES

A. Sealant for Joints in Linear Components: As recommended by component manufacturer.
B. Adhesive for Anchoring to Roof Membrane: Compatible with roof membrane and approved by roof membrane manufacturer.
C. Roof Cement: ASTM D4586/D4586M, Type I.
D. Protective Backing Paint: Zinc molybdate alkyd.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.

3.02 PREPARATION

A. To prevent galvanic action or corrosion, back paint concealed metal surfaces with protective backing paint, minimum dry film thickness of 3 mil, or provide other permanent separation as recommended by unit manufacturer, where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates.

3.03 INSTALLATION - GENERAL

A. Install components in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
B. Seal joints within components when required by component manufacturer.
C. Anchor components securely.
D. Coordinate installation of components of this section with installation of roofing membrane and base flashings.

3.04 GUTTERS AND DOWNSPOUTS

A. Secure gutters and downspouts in place with concealed fasteners.
   1. Gutter Supports: Space 30 inches on center, maximum.
   2. Downspout Supports: Locate at top and bottom of downspout and 60 inches on center, maximum.
B. Seal metal joints.
C. Slope gutters 1/4 inch per 10 feet, minimum, unless otherwise indicated.
D. Where indicated, connect downspouts to downspout boots, and seal connection watertight.

3.05 CLEANING

A. On completion of manufactured roof specialties installations, remove unused materials and clean finished surfaces as recommended by roof specialties manufacturers. Maintain finishes in clean condition.

B. Replace manufactured roof specialties damaged or deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 7100

SECTION 07 8400 - FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.
   1. Firestopping of joints and penetraftions in fire resistance rated and smoke resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.
B. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2024.
C. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems; 2024.
D. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2024.
E. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-Story Test Apparatus; 2025b.
F. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2023a, with Editorial Revision (2024).
G. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Schedule of Firestopping: List each type of penetration, each type of joint, fire rating of the penetrated assembly, firestopping test or design number, and illustration of each firestopping system.
C. Product Data: Provide data on product characteristics, performance ratings, and limitations.
D. Installer's qualification statement.

1.04 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
   1. Listing in UL (FRD) will be considered as constituting an acceptable test report.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.
C. Installer Qualifications: Company specializing in performing the work of this section and:
   1. Verification of minimum 5 years documented experience installing work of this type.

1.05 MOCK-UPS

A. Install one firestopping assembly representative of each fire rating design required on project.
   1. Where one design may be used for different penetrating items or in different wall or floor constructions, install one assembly for each different combination.
   2. Where firestopping is intended to fill a linear opening, install at least 1 linear foot of firestopping.
B. If accepted, mock-up will represent minimum standard for this work.
C. If accepted, mock-up may remain as part of this work. Remove and replace mock-ups not accepted.

1.06 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Firestopping Manufacturers:
   1. 3M Fire Protection Systems; www.3m.com.
   2. A/D Fire Protection Systems; www.adfire.com.
   3. Hilti Firestop; www.hilti.com.
   4. RectorSeal Firestop; www.rectorseal.com.
   5. Specified Technologies, Inc. (STI); www.stifirestop.com.
   6. Tremco Fire Protection Systems; www.tremcofirestop.com.
   7. Substitutions: See Section 01 6000 - Product Requirements.

2.02 MATERIALS

A. Firestopping Materials: Any materials complying with firestopping assembly design requirements including, but not limited to, the following:
   1. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
   2. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
   3. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
   4. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
   5. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
   6. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
   7. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
   8. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
   9. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
   10. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants
B. Accessory Materials: For each firestopping assembly, provide all primers, forming/damming/backing materials, collars, sleeves, and related materials for a complete installation.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. General:
   1. Provide firestopping assemblies indicated, or, if not indicated, as required to comply with fire ratings indicated.
   2. Fire Ratings: As indicated on Drawings.
   3. Joint Firestopping:
      a. Nominal Widths: As indicated on Drawings.
      b. Movement Capabilities: Class 1, 50 percent compression or extension, unless otherwise indicated or required.
B. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
   a. Temperature Rise: Provide systems that have been tested to show T Rating as indicated or required.
   b. Air Leakage: Provide systems that have been tested to show L Rating as indicated, at Smoke Barriers, and elsewhere as indicated or required.
   c. Watertightness: Provide systems that have been tested to show W Rating as indicated or required.

C. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
   1. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
      a. Movement: Provide systems that have been tested to show movement capability as indicated or required.
      b. Temperature Rise: Provide systems that have been tested to show T Rating as indicated or required.
      c. Air Leakage: Provide systems that have been tested to show L Rating as indicated or required..
      d. Where floor assembly is not required to have a fire rating, provide systems that have been tested to show L Rating as indicated or required..
   2. Head-of-Wall Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of floor or wall, whichever is greater.
      a. Movement: Provide systems that have been tested to show movement capability as indicated or required.
   3. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
      a. Movement: Provide systems that have been tested to show movement capability as indicated or required.
      b. Air Leakage: Provide systems that have been tested to show L Rating as indicated or required.
      c. Watertightness: Provide systems that have been tested to show W Rating as indicated or required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.

C. Do not cover installed firestopping until inspected by authorities having jurisdiction.

3.04 IDENTIFICATION

A. General: Install labeling required by code.

B. Wall Identification:
   1. Permanently label walls containing penetration firestopping systems with the words "FIRE /SMOKE BARRIER - PROTECT ALL OPENINGS."
      a. Use lettering not less than 3 inches high and with minimum 0.375-inch strokes.
   2. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

C. Penetration Identification:
   1. Identify each penetration firestopping system with legible metal or plastic labels.
   2. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems.
   3. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed.
   4. Include the following information on labels:
      a. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
      b. Manufacturer's name.
      c. Installer's name, address, and phone number.
      d. Designation of applicable testing and inspecting agency.
      e. Date of installation.

3.05 FIELD QUALITY CONTROL

A. Independent Testing Agency: Inspection agency employed and paid by Owner, may examine penetration firestopping in accordance with ASTM E2174, and ASTM E2393.

B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.06 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.07 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 07 8400

SECTION 07 9200 - JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nonsag gunnable joint sealants.
B. Self-leveling pourable joint sealants.
C. Joint backings and accessories.
D. Section 07 8400 - Firestopping: Firestopping sealants.
E. Section 07 9100 - Preformed Joint Seals: Precompressed foam, gaskets, and strip seals.
F. Section 08 8000 - Glazing: Glazing sealants and accessories.
G. Section 09 2116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.

1.02 REFERENCE STANDARDS

A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).
C. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).
D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
E. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2023.
F. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
G. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.
H. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2023.
I. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints; 2019 (Reapproved 2025).
J. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
    1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
    2. List of backing materials approved for use with the specific product.
    3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
    4. Substrates the product should not be used on.
    5. Substrates for which use of primer is required.
    6. Sample product warranty.
C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
D. Color Cards for Selection: Where custom colors are not specified, submit manufacturer's color cards showing standard colors available for selection.
E. Samples for Verification: For each sealant color, submit at least three physical samples for color verification.
    1. Provide 1/2 inch wide joint sealant samples formed between two 4 inch long strips of material matching appearance of exposed surfaces adjacent to joint sealants.

F. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.
G. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
H. Field Quality Control Log: Submit filled out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section and with at least 5 years of documented experience.
C. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.
    1. Adhesion Testing: In accordance with ASTM C794.
    2. Compatibility Testing: In accordance with ASTM C1087.
    3. Stain Testing: In accordance with ASTM C1248; required only for stone substrates.
    4. Allow sufficient time for testing to avoid delaying the work.
    5. Deliver to manufacturer sufficient samples for testing.
    6. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals.
    7. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.
D. Owner may employ an independent testing agency to perform the field quality control inspection and testing as referenced in PART 3 of this section and as follows, to prepare and submit the field quality control plan and log, and to provide recommendations of remedies in the case of failure.
    1. Contractor shall cooperate with testing agency and repair failures discovered.
    2. Otherwise, if Owner does not employ an independent testing agency, Contractor shall perform its own field quality control measures including the following:
        a. Field Quality Control Plan and Log.
        b. Field Adhesion Test Procedures.
E. Field Quality Control Plan:
    1. Visual inspection of entire length of sealant joints.
    2. Non-destructive field adhesion testing of sealant joints, except interior acrylic latex sealants.
        a. For each different sealant and substrate combination, allow for one test every 12 inches in the first 10 linear feet of joint and one test every 120 inches thereafter.
        b. If any failures occur in the first 10 linear feet, continue testing at 48 inch intervals at no extra cost to Owner.
F. Field Adhesion Test Procedures:
    1. Allow sealants to fully cure as recommended by manufacturer before testing.
    2. Have a copy of the test method document available during tests.
    3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
    4. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.
    5. Non-Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Spot Method.
        a. Record results on Field Quality Control Log.
        b. Repair failed portions of joints.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective work within a five year period after Date of Substantial Completion.
C. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal , exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

A. Scope:
1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
a. Wall expansion and control joints.
b. Joints between door, window, and other frames and adjacent construction.
c. Joints between different exposed materials.
d. Openings below ledge angles in masonry.
e. Other joints as indicated.
2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
a. Joints between door, window, and other frames and adjacent construction.
b. Other joints as indicated.
3. Do not seal the following types of joints.
a. Intentional weepholes in masonry.
b. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
d. Joints where installation of sealant is specified in another section.
e. Joints between suspended panel ceilings/grid and walls.
B. Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.
1. Control and Expansion Joints in Concrete Paving: Self-leveling silicone traffic-grade sealant.
C. Interior Joints: Use non-sag acrylic emulsion latex sealant, unless otherwise indicated.
1. Interior Sides of Aluminum Framing in Exterior Walls: Use non-sag non-staining silicone sealant, unless otherwise indicated.
a. Includes, but is not limited to, curtain walls, storefronts, and metal-framed skylights.
2. Control Joints in Interior Concrete Slabs: Self-leveling silicone "traffic grade" sealant.
3. Column Isolation Joints in Interior Concrete Slabs: Self-leveling silicone "traffic grade" sealant.
4. Floor Joints in Wet Areas: Self-leveling silicone "traffic grade" sealant; not for continuous liquid immersion
5. Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; clear, unless otherwise indicated.
6. Joints between countertops and walls: Mildew-resistant silicone sealant; clear, unless otherwise indicated.
D. Interior Wet Areas: Includes, but is not limited to, toilet rooms, showering areas, locker rooms, kitchens, and food service areas; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, and other similar items.

2.02 NONSAG JOINT SEALANTS

A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Type S, Uses NT, A, G, M and O; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 50 percent, minimum.
2. Non-Staining To Porous Stone: Non-staining to light-colored natural stone when tested in accordance with ASTM C1248.
3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
4. Hardness Range: Comply with one of the following:

a. 15 to 35, Shore A, when tested in accordance with ASTM C661.
b. 25 to 35, Shore A, when tested in accordance with ASTM D2240.
5. Color: Custom color(s) to match Architect's sample(s).
6. Cure Type: Single-component, neutral moisture curing.
7. Service Temperature Range: Minus 40 to 250 degrees F.
8. Products:
a. Momentive Performance Materials, Inc./GE; SCS9000 SilPruf NB: www.siliconeforbuilding.com.
b. Pecora Corporation; 890NST: www.pecora.com.
c. Sika Corporation; Sikasil WS-295 FPS: www.usa.sika.com.
d. Tremco, Inc.; Spectrem 3: www.tremcosealants.com.
e. Dow Chemical Company; DOWSIL 790 Silicone Building Sealant: consumer.dow.com/en-us/industry/ind-building-construction.html/#sle.
f. Substitutions: See Section 01 6000 - Product Requirements.

B. Traffic Grade Silicone Sealant: ASTM C920, Grade NS, Type S, Uses T, M, and O; not expected to withstand continuous water immersion.
1. Movement Capability: Plus 100 percent, minus 50 percent, minimum
2. Hardness Range: Comply with one of the following:
a. 5 to 15, Shore A, when tested in accordance with ASTM C661.
b. 85, Shore 00, when tested in accordance with ASTM C661.
3. Color: To be selected by Architect from manufacturer's full range.
4. Cure Type: Single-component, neutral moisture curing.
5. Service Temperature Range: Minus 40 to 250 degrees F.
6. Products:
a. Dow Corning; NS Parking Structure Sealant: www.dowcorning.com.
b. Pecora Corporation; 311NS: www.pecora.com.
c. Sika Corporation; Sikasil - 728 NS: www.usa.sika.com.
d. Tremco, Inc.; Spectrem 800: www.tremcosealants.com.
e. Substitutions: See Section 01 6000 - Product Requirements.

C. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Type S, Uses NT, A, G, and O; mildew resistant; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 25 percent, minimum.
2. Hardness Range: Comply with one of the following:
a. 15 to 35, Shore A, when tested in accordance with ASTM C661.
b. 25 to 35, Shore A, when tested in accordance with ASTM D2240.
3. Color: Clear.
4. Cure Type: Single-component, acetoxy or neutral moisture curing .
5. Service Temperature Range: Minus 40 to 300 degrees F.
6. Products:
a. Dow Corning; 786 Sealant M: www.dowcorning.com.
b. Momentive Performance Materials, Inc./GE; SCS1700 Sanitary: www.siliconeforbuilding.com.
c. Pecora Corporation; 898NST: www.pecora.com.
d. Sika Corporation; Sikasil - GP: www.usa.sika.com.
e. Tremco, Inc.; Tremsil 200 with fungicide: www.tremcosealants.com.
f. Substitutions: See Section 01 6000 - Product Requirements.

D. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, non-staining, non-bleeding, non-sagging; not intended for exterior use. Siliconized.
1. Color: To be selected by Architect from manufacturer's full range.
2. Grade: ASTM C834; Grade Minus 18 Degrees C (0 Degrees F).
3. Products:
a. Franklin International Inc; Titebond Painter's Plus Caulk: www.titebond.com.
b. Pecora Corporation; AC-20 +Silicone: www.pecora.com.
c. Sherwin Williams; 950A Siliconized Acrylic Latex Caulk: www.sherwin-williams.com.

d. Tremco, Inc.; Tremflex 834: www.tremcosealants.com.
e. Substitutions: See Section 01 6000 - Product Requirements.

2.03 SELF-LEVELING SEALANTS

A. Self-Leveling Silicone Sealant: ASTM C920, Type S, Grade P, Uses T, M and O; single-component, explicitly approved by manufacturer for traffic exposure when recessed below traffic surface; not expected to withstand continuous water immersion.
1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
2. Hardness Range: Comply with one of the following:
a. 5 to 20, Shore A, when tested in accordance with ASTM C661.
b. 40 to 85, Shore 00, when tested in accordance with ASTM D2240.
3. Color: To be selected by Architect from manufacturer's full range.
4. Cure Type: Single-component, neutral moisture curing.
5. Service Temperature Range: Minus 50 to 300 degrees F.
6. Products:
a. Dow Corning; SL Parking Structure Sealant: www.siliconeforbuilding.com.
b. Pecora Corporation; 310SL: www.pecora.com.
c. Sika Corporation; Sikasil-728 SL: www.usa.sika.com.
d. Tremco, Inc.; Spectrem 900SL: www.tremcosealants.com.
e. Substitutions: See Section 01 6000 - Product Requirements.

2.04 ACCESSORIES

A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
1. Type for Joints Not Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
2. Type for Joints Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
3. Bi-Cellular: 25 to 33 percent larger in diameter than joint width.

B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.

C. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.

D. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Verify that backer rods are of the correct size.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in inconspicuous area to verify that it does not stain or discolor slab.

3.03 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C1193.

C. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer.
D. Install bond breaker backing tape where backer rod cannot be used.
E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
F. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
G. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
H. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.
I. Installation of Two-Stage Joints at Precast Architectural Concrete Units:
    1. Joint system consists of two back-to-back sealant joints at each precast architectural concrete unit joint with a weep at the bottom of the unit joint per Precast/Prestressed Concrete Institute (PCI) recommendations and as follows:
        a. Inner (Secondary) Seal: Inner secondary backer rod and sealant joint is installed a minimum of 2 to 2-1/2 inches beyond the exposed face of the precast architectural concrete panels within the panel joint itself.
        b. Exterior (Primary) Seal: Following the installation of the secondary joint, the outer primary backer rod and sealant joint is installed at the face of the precast architectural concrete panels with a weep at the bottom of the joint. Leave open continuous air space between the primary backer rod and inner secondary seal.
        c. Install 3/8 inch minimum weep openings in the exterior seal to allow water penetrating the exterior seal and contained by the inner seal to exit the cavity between joint seals.
            1) Do not install weeps below finish grades.
        d. Near the junction of horizontal and vertical joints, the inner seal must turn out to the plane of the exterior seal at regular intervals to force water out of the joint.

3.04 FIELD QUALITY CONTROL

A. Owner may employ an independent testing agency to perform field quality control inspection and testing as specified in PART 1 under QUALITY ASSURANCE article.
B. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet, notify Architect immediately.
C. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

END OF SECTION 07 9200

SECTION 07 9513 - EXPANSION JOINT COVER ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Expansion joint cover assemblies for floor, wall, and ceiling surfaces.
   1. Interior expansion joint cover assemblies.
   2. Exterior expansion joint cover assemblies.

1.02 RELATED REQUIREMENTS

A. Section 07 9100 - Preformed Joint Seals: Sealing expansion and control joints using preformed joint seals.

1.03 REFERENCE STANDARDS

A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2024.
B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
D. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles; 2020.
E. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
F. ITS (DIR) - Directory of Listed Products; Current Edition.
G. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Installation Templates: For frames and anchors to be embedded in concrete or masonry, furnish templates to relevant installers; include installation instructions and tolerances.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices, available colors and finish, and fire ratings.
C. Shop Drawings: Indicate joint and splice locations, miters, layout of the work, affected adjacent construction, anchorage locations, and fire ratings.
   1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work.
   2. Include transition and termination details.
D. Expansion Joint Cover Assembly Schedule: Include the following information in tabular form:
   1. Manufacturer and model number for each expansion joint cover assembly.
   2. Expansion joint cover assembly location cross-referenced to Drawings.
   3. Nominal, minimum, and maximum joint width.
   4. Movement direction.
   5. Materials, colors, and finishes.
   6. Product options.
   7. Fire-resistance ratings.
E. Samples: For each expansion joint cover assembly, submit three samples 6 inch long, illustrating profile, dimension, color, and finish selected.
F. Manufacturer's Installation Instructions: Indicate rough-in sizes and required tolerances for item placement.
G. Field Quality Control: Submit field inspection reports.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.

B. Installer Qualifications: Company specializing in installing products of the type specified in this section with minimum 5 years of documented experience and approved by manufacturer.

1.07 MOCK-UP

A. Mock-ups: Build mock-ups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Build mockup of each type of expansion joint cover assembly.
   2. Locate where directed by Architect.
   3. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 EXPANSION JOINT COVER ASSEMBLY APPLICATIONS - EXTERIORS

A. Wall Joint Cover - Elastomeric Seal: Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.
   1. Application: Wall to wall and wall to corner.
   2. Exposed Metal: Aluminum.
   3. Seal: Preformed elastomeric membranes or extrusions.
   4. Nominal Joint Width: 2 inches.
   5. Minimum Joint Width: 1-1/2 inch.
   6. Maximum Joint Width: 3 inches.
   7. Fire Resistance Rating: Not less than that of adjacent construction.
   8. Secondary Moisture Barrier: Manufacturer's standard elastomeric moisture barrier.
   9. Finishes:
      a. Aluminum: Mill.
      b. Elastomeric Seal: As selected by Architect from manufacturer's standard colors.
   10. Products:
      a. Balco, Inc.; FC Series: www.balcousa.com.
      b. Construction Specialties, Inc; SF Series: www.c-sgroup.com.
      c. Inpro Corp; 611 Series: www.inprocorp.com.
      d. MM Systems Corp.; VSS Series: www.mmsystemcorp.com.
      e. Nystrom; EWN Series: www.nystrom.com.
      f. Watson Bowman Acme Corp./BASF Corp; WSW Series: www.wbacorp.com.
      g. Substitutions: See Section 01 6000 - Product Requirements.

2.02 EXPANSION JOINT COVER ASSEMBLY APPLICATIONS - INTERIORS

A. Floor Joint Cover - Surface Mounted, Metal Plate: Metal cover plate fixed on one side of joint gap and free to slide on other.
   1. Application: Floor to floor and floor to wall.
   2. Installation: Surface mounted.
   3. Exposed Metal: Aluminum.
   4. Cover Plate Style: Smooth or serrated.
   5. Nominal Joint Width: 2 inches.
   6. Minimum Joint Width: 0 inches.
   7. Maximum Joint Width: 3 inches.
   8. Fire Resistance Rating: Not less than that of adjacent construction.
   9. Secondary Moisture Barrier: None.
   10. Load Capacity - Concentrated Load: 500 lbs.
   11. Finishes:
      a. Aluminum: Mill.
   12. Products:
      a. Balco, Inc.; RPA/RPAL Series: www.balcousa.com.
      b. Construction Specialties, Inc; PC/PCW Series: www.c-sgroup.com.
      c. Inpro Corp; 801-A01/801-A02Series: www.inprocorp.com.
      d. MM Systems Corp.; SP Series: www.mmsystemcorp.com.
      e. Nystrom; DT/SW Series: www.nystrom.com.
      f. Watson Bowman Acme Corp./BASF Corp; FJF/FJFc Series: www.wbacorp.com.

g. Substitutions: See Section 01 6000 - Product Requirements.

B. Floor Joint Cover - Recessed Mounted, Metal Glide Plate: Assembly consisting of center metal plate that slides in and out of recessed metal frames fixed to sides of joint gap; recessed frames covered by floor finish.
1. Application: Floor to floor and floor to wall.
2. Installation: Recessed.
3. Exposed Metal: Aluminum.
4. Nominal Joint Width: 2 inches.
5. Minimum Joint Width: 1 inches.
6. Maximum Joint Width: 3 inches.
7. Fire Resistance Rating: Not less than that of adjacent construction.
8. Secondary Moisture Barrier: None.
9. Load Capacity - Concentrated Load: 500 lbs.
10. Finishes:
a. Aluminum: Mill.
11. Products:
a. Balco, Inc.; 6000 Series: www.balcousa.com.
b. Construction Specialties, Inc; ALR/ALRW Series: www.c-sgroup.com.
c. Inpro Corp; 304 Series: www.inprocorp.com.
d. MM Systems Corp.; HFXR Series: www.mmsystemcorp.com.
e. Nystrom; NBR Series: www.nystrom.com.
f. Watson Bowman Acme Corp./BASF Corp; CCF Series: www.wbacorp.com.
g. Substitutions: See Section 01 6000 - Product Requirements.

C. Wall Joint Cover - Surface Mounted, Metal Plate: Metal cover plate fixed on one side of joint gap and free to slide on other.
1. Application: Wall to wall and wall to corner.
2. Installation: Surface mounted.
3. Exposed Metal: Aluminum.
4. Nominal Joint Width: 2 inches.
5. Minimum Joint Width: 1/2 inch.
6. Maximum Joint Width: 3 inches.
7. Fire Resistance Rating: Not less than that of adjacent construction.
8. Finishes:
a. Aluminum: Clear anodized.
9. Products:
a. Balco, Inc.; WD/WDC Series: www.balcousa.com.
b. Construction Specialties, Inc; ASM/ASMC Series: www.c-sgroup.com.
c. Inpro Corp; 811 Series: www.inprocorp.com.
d. MM Systems Corp.; XM Series: www.mmsystemcorp.com.
e. Nystrom; WJ Series: www.nystrom.com.
f. Watson Bowman Acme Corp./BASF Corp; EWH Series: www.wbacorp.com.
g. Substitutions: See Section 01 6000 - Product Requirements.

D. Wall Joint Cover - Flush Mounted, Metal Glide Plate: Assembly consisting of center metal plate that slides in and out of recessed metal frames fixed to sides of joint gap; recessed frames flush with face of wall, designed for gypsum board.
1. Application: Wall to wall and wall to corner.
2. Installation: Recess mounted.
3. Exposed Metal: Aluminum.
4. Nominal Joint Width: 2 inches.
5. Minimum Joint Width: 1/2 inch.
6. Maximum Joint Width: 3 inches.
7. Fire Resistance Rating: Not less than that of adjacent construction.
8. Finishes:
a. Aluminum: Clear anodized.

9. Products:
   a. Balco, Inc.; 6000 Series: www.balcousa.com.
   b. Construction Specialties, Inc; AFW/AFWC Series: www.c-sgroup.com.
   c. Inpro Corp; 300 Series: www.inprocorp.com.
   d. MM Systems Corp.; FX-K Series: www.mmsystemcorp.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.

E. Ceiling Joint Cover - Elastomeric Seal: Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap, includes drywall bead for mudding to gypsum board.
1. Application: Ceiling to ceiling and ceiling to wall.
2. Installation: Flush mounted.
3. Exposed Metal: Aluminum.
4. Seal: Preformed elastomeric membranes or extrusions
5. Nominal Joint Width: 2 inches.
6. Minimum Joint Width: 1 inches.
7. Maximum Joint Width: 3-1/2 inches.
8. Fire Resistance Rating: Not less than that of adjacent construction.
9. Finishes:
   a. Aluminum: Mill.
   b. Elastomeric Seal: As selected by Architect from manufacturer's standard colors.
10. Products:
   a. Balco, Inc.; GCWW/GCWC Series: www.balcousa.com.
   b. Construction Specialties, Inc; FWS/FWSC Series: www.c-sgroup.com.
   c. Inpro Corp; 114 Series: www.inprocorp.com.
   d. MM Systems Corp.; VSW Series: www.mmsystemcorp.com.
   e. Nystrom; LCD Series: www.nystrom.com.
   f. Watson Bowman Acme Corp./BASF Corp; CWWS Series: www.wbacorp.com.
   g. Substitutions: See Section 01 6000 - Product Requirements.

F. Acoustical Ceiling Joint Cover - Elastomeric Seal: Elastomeric-seal assembly designed for use in suspended acoustical ceilings.
1. Application: Ceiling to ceiling and ceiling to wall.
2. Installation: Flush mounted.
3. Exposed Metal: Aluminum.
4. Seal: Preformed elastomeric membranes or extrusions
5. Nominal Joint Width: 2 inches.
6. Minimum Joint Width: 1 inches.
7. Maximum Joint Width: 3-1/2 inches.
8. Finishes:
   a. Aluminum: Mill.
   b. Elastomeric Seal: As selected by Architect from manufacturer's standard colors.
9. Products:
   a. Balco, Inc.; ACWW/ACWC Series: www.balcousa.com.
   b. Construction Specialties, Inc; FCS/FCSC Series: www.c-sgroup.com.
   c. Inpro Corp; 115 Series: www.inprocorp.com.
   d. MM Systems Corp.; VSG Series: www.mmsystemcorp.com.
   e. Nystrom; LCE Series: www.nystrom.com.
   f. Watson Bowman Acme Corp./BASF Corp; CEB Series: www.wbacorp.com.
   g. Substitutions: See Section 01 6000 - Product Requirements.

2.03 EXPANSION JOINT COVER ASSEMBLIES - GENERAL

A. Expansion Joint Cover Assemblies - General: Factory-fabricated and assembled; designed to completely fill joint openings, sealed to prevent passage of air, dust, water, smoke; suitable for traffic expected.
1. Lengths: Provide covers in full lengths required; avoid splicing wherever possible.
2. Anchors, Fasteners, and Fittings: Provided by cover manufacturer.

B. Provide factory fabricated corners, changes in direction, transitions, and terminations.

C. Floor Joint Covers: Coordinate with indicated floor coverings.
D. Sliding Cover Plate Type Covers: Provide plate with beveled edges and neat fit that does not collect dirt.
E. Covers In Gypsum Board Assemblies: Provide style with anchoring wings that can be completely covered by joint compound.
F. Covers In Fire Rated Assemblies: Provide cover assembly having fire rating equivalent to that of assembly into which it is installed.
1. Acceptable Evaluation Agencies: UL (DIR) and ITS (DIR).

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper; or ASTM B308/B308M, 6061 alloy, T6 temper.
B. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.
C. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.
D. Secondary Moisture Barriers: Manufacturer's standard, continuous, moisture and vapor barrier membrane; within joint and attached to substrate on sides of joint.
E. Anchors and Fasteners: As recommended by cover manufacturer.
F. Ferrous Metal Anchors: Galvanized where embedded in concrete or in contact with cementitious materials.
G. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
H. Backing Paint for Aluminum Components in Contact with Cementitious Materials: Asphaltic type.

2.05 FINISHES

A. Aluminum Finishes:
1. Mill finish.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joint preparation and dimensions are acceptable and in accordance with manufacturer's requirements.

3.02 INSTALLATION

A. Install components and accessories in accordance with manufacturer's instructions.
B. Align work plumb and level.
C. Rigidly anchor to substrate to prevent misalignment.
1. At recessed floor joint assemblies, grout annular spaces between concrete slab and floor joint framing solid with nonshrink, nonmetallic grout; make flush with concrete floor slab.
D. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
1. Ensure that fire-resistance rated expansion joint assemblies comply with performance requirements of tested assemblies.
E. Secondary Moisture Barrier: Install continuous, uninterrupted barrier throughout length of joint, including transitions and field splices.
F. Do not install final covers of expansion joint assemblies until internal components inspected by manufacturer's representative.

3.03 FIELD QUALITY CONTROL

A. Provide manufacturer's representative to inspect installation of expansion joint cover assemblies, including internal fire barriers, secondary moisture barriers, transitions and terminations, and overall installation.
   1. Provide inspection reports.

3.04 PROTECTION

A. Touch-up, repair, or replace damaged expansion joint assemblies before Date of Substantial Completion

B. Do not permit traffic over unprotected floor joint surfaces.

END OF SECTION 07 9513

SECTION 08 1113 - HOLLOW METAL FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-fire-rated hollow frames.
B. Hollow metal frames for wood doors.
   1. Including fire-rated frames
C. Fire-rated hollow frames.
D. Thermally insulated hollow metal frames.
E. Hollow metal borrowed lites glazing frames.

1.02 ABBREVIATIONS AND ACRONYMS

A. ANSI: American National Standards Institute.
B. BHMA - Builders Hardware Manufacturers Association.
C. NFPA: National Fire Protection Association.
D. SDI: Steel Door Institute.
E. UL: Underwriters Laboratories.

1.03 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
B. ANSI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames.; 2003.
C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2025.
E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
G. ASTM A1011/A1011M - 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; 2023.
H. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
I. ASTM C476 - Standard Specification for Grout for Masonry; 2023.
J. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
L. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
M. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
N. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.
O. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2022.
P. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

1. Include details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.

D. Manufacturer's Qualification Statement.

E. Installer's Qualification Statement.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 5 years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with ANSI A250.8 (SDI-100) in accordance with specified requirements.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide manufacturer warranty for doors and frames to be free from material or workmanship defects and within commercial tolerances within a 1 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hollow Metal Frames:

1. Ceco Door, an Assa Abloy Group company; _____: www.assaabloydss.com/#sle.
2. Curries, an Assa Abloy Group company: www.curries.com.
3. De La Fontaine: www.delafontaine.com.
4. Mesker/Mesker Openings Group, a Dormakaba Group company: www.meskeropeningsgroup.come.
5. Pioneer Industries, an Assa Abloy Group company: www.pioneerindustries.com.
6. Republic Doors, an Allegion brand: www.republicdoor.com.
7. Steelcraft, an Allegion brand: www.allegion.com.
8. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

A. Requirements for Hollow Metal Doors and Frames:

1. Steel Sheet: Comply with one or more of the following requirements; galvannealed steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
2. Accessibility: Comply with ICC A117.1 and ADA Standards.
3. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
4. Hardware Preparations, Selections and Locations: Comply with BHMA A156.115 and ANSI A250.8 (SDI-100) in accordance with specified requirements and as follows:
   a. Minimum Hardware reinforcing thicknesses:
      1) Mortise Butt Hinges: 0.123 inches (10 gage),
      2) Pivot Hinges: 0.167 inches (7 gage)
      3) Continuous Hinges: 0.067 inches (14 gage).
      4) Exit Devices: 0.067 inches (14 gage)
      5) Mortise Locksets and Deadbolts: 0.067 inches (14 gage).
      6) Bored Locksets and Deadbolts: 0.067 inches (14 gage).
      7) Flush and Surface Bolts: 0.067 inches (14 gage).
      8) Closers and Hold Open Arms: 0.067 inches (14 gage).
      9) Pull Plates and Push/Pull Bars: 0.067 inches (14 gage).
      10) Protection Plates and Push Plates: No reinforcing required.

5. Zinc Coating: Where indicated, provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M.
    a. Minimum A60/ZF180 (galvannealed) coating unless otherwise indicated.

B. Hollow Metal In-Fill Panels: Same construction, performance, and finish as doors.

C. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL FRAMES

A. Hollow metal frames based on SDI Standards: ANSI A250.8 (SDI-100).
    1. Joints between faces of abutting frame members shall appear seamless; joints shall be securely welded, filled, and and finished smooth without visible seams.

B. Frame Finish: Factory primed and field finished.

C. Exterior Door Frames: Full profile/continuously welded type.
    1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A60/ZF180 coating.
    2. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
    3. Weatherstripping: Separate, see Section 08 7100.

D. Door Frames, Fire-Rated: Full profile/continuously welded type.
    1. Fire Rating: Same as door, labeled.
    2. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
    3. Includes frames for wood doors.
    4. For Exterior Fire-Rated Doors provide the following:
        a. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A60/ZF180 coating.

E. Borrowed Light Frames: Full profile/continuously welded type.
    1. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
    2. Face dimensions to match door frames.

F. Mullions for Pairs of Doors: Where indicated provide fixed mullions with profile similar to jambs.
    1. Refer to Section 08 7100 - Door Hardware for removable mullions.

G. Transom Bars: Fixed, of profile same as jamb and head.

H. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.

I. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.

J. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

K. Frame Anchors:
    1. Provide anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
    2. Floor Anchors: Base anchors welded to bottom of frames, designed to attach frame to floor.
    3. Masonry Anchors: Masonry anchors shall be T-strap type, corrugated or perforated.
    4. Stud Anchors: Z-type, welded to back of frames.
    5. In-Place Concrete or Masonry Wall Anchors: Minimum 3/8 inch diameter bolts with expansion shields or inserts, with manufacturer's standard spacer.
        a. For existing walls or new openings cut into existing walls

2.04 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

B. Corrosion Resistant Back-Coating: Automotive undercoating, asphalt emulsion, or other high-build, water-resistant, resilient coating.

2.05 ACCESSORIES

A. Louvers: Roll formed steel with overlapping frame; finish same as door components; factory-installed.
   1. Style: Sightproof inverted V or Y blades.
   2. Louver Free Area: 50 percent.
   3. Fasteners: Concealed fasteners.

B. Glazing: As specified in Section 08 8000.

C. Removable Stops: Formed sheet steel, mitered or butted corners; prepared for countersink style tamper proof screws.
   1. At Contractor's option, instead of glass stops provided by door manufacturer, provide fire rated glass manufacturer’s standard vision lite kits for installing fire-rated glass in doors.
      a. Refer to Section 08 8000 - Glazing.

D. Astragals for Double Doors: Specified in Section 08 7100.

E. Grout for Frames: Mortar grout complying with ASTM C476 with maximum slump of 4 inches as measured in accordance with ASTM C143/C143M for hand troweling in place; plaster grout and thinner pumpable grout are prohibited.
   1. Comply with requirements of Section 04 2000 - Unit Masonry.

F. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.

G. Filler: Two-component, non-shrinking resin, autobody filler.
   1. Available Products:
      a. 3M/Bondo; Professional Gold Body Filler: www.bondo.com.

H. Mineral Fiber Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread and smoke developed indexes of 0 (zero) when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 PREPARATION

A. Back-Coating of Non-Rated Frames: Field-apply corrosion resistant back-coatings to frames that are to be grouted solid.
   1. Do not back-coat fire-rated frames.

3.03 INSTALLATION

A. Install frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.

B. Install smoke control units in accordance with NFPA 105.

C. Set frames accurately in position, aligned, plumb, and square.

D. Fill head and jamb members with mineral fiber insulation prior to installation.
   1. Exception: Do not fill frames that are to be grouted solid.

E. Grout frames solid in masonry and concrete construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
   1. Install silencers prior to grouting frames.
   2. Do not grout fire-rated frames; instead fill head and jamb members with mineral fiber insulation.

F. Frame Anchors:
   1. Coordinate frame anchor placement with wall construction.

2. Minimum number of anchors:
   a. Provide 3 jamb anchors per jamb up to 90 inches in height; evenly spaced.
   b. Provide 4 jamb anchors per jamb from 90 to 144 inches in height; evenly spaced.
   c. Provide 1 additional anchor per jamb for each 24 inches or fraction thereof more than 144 inches in height.
   d. Provide 1 floor anchor at the bottom of each jamb or mullion; where a floor anchor is not possible provide one additional jamb anchor.
3. In-Place Concrete or Masonry Wall Anchor: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

G. Install glass in accordance with Section 08 8000 - Glazing.

H. Install door hardware as specified in Section 08 7100.

I. Coordinate installation of electrical connections to electrical hardware items.

3.04 TOLERANCES

A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117.

B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.05 ADJUSTING

A. Adjust for smooth and balanced door movement.

END OF SECTION 08 1113

SECTION 08 1416 - FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flush wood doors; flush and flush glazed configuration; fire-rated and non-rated.

1.02 REFERENCE STANDARDS

A. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2024.
B. ITS (DIR) - Directory of Listed Products; Current Edition.
C. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
D. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2022.
E. UL (DIR) - Online Certifications Directory; Current Edition.
F. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
G. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
    1. Provide information as required by AWI/AWMAC/WI (AWS).
    2. Include details of electrical raceway and preparation for electrified hardware, access control systems, and security systems
D. Samples: Submit three samples of door veneer, 8 by 10 inch in size illustrating wood grain, stain color, and sheen.
    1. Transparent finish Samples shall illustrate typical range of wood color and grain.
E. Manufacturer's Qualification Statement.
F. Installer's Qualification Statement.
G. Warranty, executed in Owner's name.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than 5 years of documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than 5 years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package, deliver and store doors in accordance with specified quality standard.
B. Accept doors on site in manufacturer's packaging, and inspect for damage.
C. Protect doors with resilient packaging. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges if stored more than one week. Break seal on site to permit ventilation.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Interior Doors: Provide manufacturer's warranty for the life of the installation.
C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Wood Veneer Faced Doors:

1. Masonite Architectural; Cendura Standard Wood Veneer Doors : www.architectural.masonite.com/#sle.
2. Mohawk Doors, Masonite Architectural: https://architectural.masonite.com.
3. Oshkosh Door Company: www.oshkoshdoor.com.
4. VT Industries, Inc: www.vtindustries.com.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. High Pressure Decorative Laminate (HPDL) Faced Doors:

C. Lead-Lined Wood Doors:

D. Sound-Rated Wood Doors:

2.02 DOORS

A. Doors: See drawings for locations and additional requirements.
1. Quality Standard: Premium Grade, Extra Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.
2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
3. High Pressure Decorative Laminate (HPDL) Faced Doors: 5-ply unless otherwise indicated.

B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
1. Provide solid core doors at each location.
2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
3. Smoke and Draft Control Doors: In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch wg pressure at both ambient and elevated temperatures for "S" label.
4. Wood veneer facing with factory transparent finish.
5. High pressure decorative laminate (HPDL) finish as indicated on drawings.

2.03 DOOR CORES

A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.

B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.04 DOOR FACINGS

A. Veneer Facing for Transparent Finish:
1. Species and Cut:
a. Species: Select White Maple.
b. Cut: Plain sliced (flat cut).
c. Grade: HPVA Grade A.
2. Veneer Matching:
a. Matching of Adjacent Veneer Leaves: Book match.
b. Matching Within Door Faces: Center balance match.
3. Vertical Edges: Same species hardwood edge as face veneer.
4. "Pair Match" each pair of doors; "Set Match" pairs of doors within 10 feet of each other when doors are closed.
5. Transoms: Continuous match to doors.

B. Veneer Facing for Opaque Finish: Closed grain hardwood veneer, in compliance with indicated quality standard.

C. Facing Adhesive: Type II - water resistant.

2.05 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.

B. Cores Constructed with stiles and rails:

1. Provide solid blocks at lock edge and top of door for closer for hardware reinforcement.
2. Provide solid blocking for other throughbolted hardware.
3. Provide sollid mid-rail blocking, in doors indicated to have exit devices.

C. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.

D. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

E. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.

F. Provide edge clearances in accordance with the quality standard specified.

2.06 FINISHES - WOOD VENEER DOORS

A. Finish work in accordance with AWI/AWMAC/WI (AWS), Section 5 - Finishing for grade specified and as follows:
1. Transparent:
a. System 5 - Conversion Varnish, System 10 - UV Curable Water-based, or System 11 - Catalyzed Polyurethane.
b. Stain: As selected by Architect.
c. Sheen: Satin.

B. Seal door top edge with color sealer to match door facing.

2.07 ACCESSORIES

A. Wood Door Frames: As specified in Section 06 4023 - {\t\#1000008}.

B. Hollow Metal Door Frames: As specified in Section 08 1113 - Hollow Metal Frames.

C. Metal Louvers:
1. Material and Finish: Roll formed steel; pre-painted finish to color as selected.
2. Louver Blade: Inverted V or Y blade, sight proof.
3. Louver Free Area: 50 percent.
4. Frame: Overlapping style with tamper proof fasteners.
5. In Fire-Rated Doors: UL (DIR) or ITS (DIR) listed fusible link louver, same rating as door.

D. Glazing: See Section 08 8000.

E. Glazing Stops:
1. Non-Rated Doors: Rolled steel channel shape, mitered corners; prepared for countersink style tamper proof screws.
a. Type: Lipped moldings.
2. Fire-Rated Doors: Rolled steel channel shape, mitered corners; prepared for countersink style tamper proof screws.
a. Type: Lipped moldings.

F. Door Hardware: See Section 08 7100.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

A. Install doors in accordance with manufacturer's instructions and specified quality standard.
1. Install fire-rated doors in accordance with NFPA 80 requirements.
2. Install smoke and draft control doors in accordance with NFPA 105 requirements.

B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.

C. Use machine tools to cut or drill for hardware.

D. Coordinate installation of doors with installation of frames and hardware.

E. Coordinate installation of glazing.

F. Install door louvers plumb and level.
G. Install glass in accordance with Section 08 8000 - Glazing.
H. Install door hardware as specified in Section 08 7100 - Door Hardware.
I. Coordinate installation of electrical connections to electrical hardware items.

3.03 TOLERANCES

A. Comply with specified quality standard for fit and clearance tolerances.
B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

A. Adjust doors for smooth and balanced door movement.
B. Adjust closers for full closure.

END OF SECTION 08 1416

SECTION 08 1610 - FRP-FACED ALUMINUM DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flush aluminum doors with fiberglass reinforced plastic (FRP) face sheets.
   1. Includes FRP-faced aluminum doors installed in storefront framing and curtainwall framing.
B. Aluminum insert framing.

1.02 ABBREVIATIONS

A. FRP: Fiberglass reinforced plastic.

1.03 REFERENCE STANDARDS

A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.
B. AAMA 701/702 - Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals; 2011.
C. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
D. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
F. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
G. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
I. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
J. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
K. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).
L. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates; 2023.
M. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.
N. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films; 2007 (Reapproved 2015).
O. ASTM D570 - Standard Test Method for Water Absorption of Plastics; 2022.
P. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2022.
Q. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; 2017.
R. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor; 2013a.
S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
T. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's descriptive literature for each type of door and frame; include information on fabrication methods, hardware preparation, accessories, installation, and maintenance instructions.
C. Shop Drawings: Include elevations of each opening type and details at each wall type.
   1. Include details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
D. Selection Samples: Complete set of color and finish options, using actual materials, for Architect's selection.
E. Verification Samples: Three actual pieces of products in each finish specified, not less than 4 inches square or 6 inches long for linear components.
F. Manufacturer's Qualification Statement.
G. Installer's Qualification Statement.
H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than five years of documented experience.
B. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver aluminum components in manufacturer's standard protective packaging, palleted, crated, or banded together.
B. Inspect delivered components for damage and replace. Repaired components will not be accepted.
C. Store components in clean, dry, indoor area, under cover in manufacturer's packaging until installation.
D. Protect materials and finish from damage during handling and installation.

1.07 FIELD CONDITIONS

A. Do not begin installation of interior aluminum components until space has been enclosed and ambient thermal conditions are being maintained at levels consistent with final project requirements.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide ten year manufacturer warranty for defects in workmanship and materials.
C. Provide 25 year warranty on fiberglass reinforced plastic (FRP) face sheets covering delamination, bubbling, and panel corrosion.
D. Provide 20 year warranty on aluminum finishes in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flush Aluminum Doors with Fiberglass Reinforced Plastic (FRP) Face Sheets:
   1. Special-Lite, Inc.; SL-17 Door: www.special-lite.com.
   2. Substitutions: See Section 01 6000 - Product Requirements.
B. Aluminum Insert Framing:

1. Special-Lite, Inc.; 10-30 Series Inset Framing: www.special-lite.com.
2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 DESIGN CRITERIA

A. Provide door assemblies that have been designed and fabricated in compliance with specified performance requirements.
B. Factory install door hardware to the greatest extent possible.
C. Accessibility: Conform to ICC A117.1 and ADA Standards.
D. Door Dimensions and Shapes: As indicated on Drawings; dimensions indicated are nominal.
   1. Provide the following clearances:
      a. Hinge and Lock Stiles: 1/8 inch.
      b. Between Meeting Stiles: 1/4 inch.
      c. At Top Rail and Bottom Rail: 1/8 inch.

2.03 MATERIALS

A. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy 5005, temper H14, stretcher leveled.
B. Extruded Aluminum: ASTM B221 (ASTM B221M), alloy 6063, temper T5, or alloy 6463, temper T5.
C. Fiberglass Reinforced Plastic (FRP) Face Sheet Properties:
   1. Ultraviolet stabilized.
   2. Surface Burning Characteristics: Flame spread index (FSI) of 76 to 200, Class C, and smoke developed index (SDI) of 450 or less; when tested in accordance with ASTM E84.
   3. Izod Impact Resistance: ASTM D256, 12 ft lbf/inch of width, minimum, with notched izod.
   4. Tensile Strength at Break: ASTM D638, 13,000 psi, minimum.
   5. Water Absorption: ASTM D570, 0.20 percent, maximum, after 24 hours at 74 degrees F.
   6. Flexural Strength: ASTM D790, 21,000 psi, minimum.
   7. Barcol Hardness: ASTM D2583, minimum of 50 units.
D. Foam Insulation Fill Material:
   1. Manufacturer's standard polystyrene or polyurethane foam.
      a. Compressive Strength:
         1) Polyurethane: 60 psi; ASTM D1621.
      b. Thermal Resistance:
         1) Polyurethane: R-value 6.8 per inch, minimum; ASTM C518.

2.04 DOORS

A. Flush Aluminum Doors with Fiberglass Reinforced Plastic (FRP) Face Sheets:
   1. Overall Door Thickness: 1-3/4 inches.
   2. Internal Framing: Extruded aluminum tubing, 1/8 inch minimum thickness, with heavy-duty plated steel through bolts in rails.
      a. Top and Bottom Rails: 6 inches wide.
      b. Side Stiles: 2-1/2 inches wide.
   3. Provide manufacturer's standard aluminum and steel reinforcements for door hardware; 1/8 inch minimum thickness.
   4. Facing: Seamless laminated FRP sheet.
      a. Sheet Thickness: 0.12 inch, minimum.
      b. Texture - FRP: Pebble grain.
      c. Color: As selected by Architect from manufacturer's standard line.
   5. Perimeter Edges: Extruded aluminum caps or returns that capture and secure edges of FRP face sheets.
      a. Door Edge Profile: Hinged edge square, and lock edge beveled.
   6. Core: Foam insulation fill material.
   7. Vision Lites: Extruded aluminum framed, gasket glazed.
      a. Glazing: As specified in Section 08 8000 - Glazing.
   8. Aluminum Finish: Superior performing organic coating.
      a. Color: As selected by Architect from manufacturer's standard line.
   9. Hardware:

a. Weatherstripping: Replaceable pile type; at jambs and head of exterior doors.
b. Bottom Sweep: Manufacturer's concealed adjustable bottom brush.
c. Door Pulls: Provide recessed flush door pulls, unless otherwise indicated.
1) Products:
(a) Special-Lite, Inc.; SL-82: www.special-lite.com.
(b) Substitutions: See Section 01 6000 - Product Requirements.
d. Balance of Hardware: Refer to Section 08 7100 - Door Hardware.

2.05 INSERT FRAMING

A. Insert Framing: Extruded aluminum door framing designed for installation within existing door framing.
1. Extruded aluminum shapes, not less than 0.125 inch thick.
2. Includes integral door stop.
3. Weatherstripping: Replaceable pile type.
4. Corner Joints: Mitered.
5. Finish: Same as doors.

2.06 MISCELLANEOUS COMPONENTS

A. Louvers: Blades and frame of extruded aluminum, minimum 0.06 inch thick; size as indicated.
1. Style: Sightproof inverted V or Y blades

2.07 FINISHES FOR ALUMINUM

A. Superior Performing Organic Coatings: Multiple coats, thermally cured polyvinylidene fluoride (PVDF) system; AAMA 2605.
1. Polyvinylidene fluoride (PVDF) multi-coat thermoplastic fluoropolymer coating system, with minimum 70 percent PVDF color topcoat and minimum dry film thickness 0.9 mil; color and gloss as indicated on drawings.
2. Color: Two or three-coat custom color to match Architect's sample.
B. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.08 ACCESSORIES

A. Replaceable Weatherstripping: AAMA 701/702 wool pile.
B. Fasteners: Aluminum, non-magnetic stainless steel, or other material warranted by manufacturer as non-corrosive and compatible with aluminum components.
1. Provide concealed fasteners where possible.
2. Exposed fasteners shall match finish of doors and frames.
C. Brackets and Reinforcements: Manufacturer's high-strength aluminum units where feasible, otherwise, non-magnetic stainless steel or steel hot-dip galvanized in compliance with ASTM A123/A123M.
D. Laminating Adhesive: Manufacturer's standard low-VOC materials.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that wall surfaces and openings are ready to receive frames and are within tolerances specified in manufacturer's instructions.
B. Verify that frames installed by other trades for installation of doors of this section are in strict accordance with recommendations and approved shop drawings and within tolerances specified in manufacturer's instructions.
C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Perform cutting, fitting, forming, drilling, and grinding of frames as required for project conditions.
B. Replace components with damage to exposed finishes.
C. Separate dissimilar metals to prevent electrolytic action between metals.

3.03 INSTALLATION

A. Install doors in accordance with manufacturer's instructions.

B. Set frames plumb, square, level, and aligned to receive doors. Anchor frames to adjacent construction in strict accordance with manufacturer's recommendations and within specified tolerances.

C. Where aluminum surfaces contact metals other than stainless steel, zinc, or small areas of white bronze, protect from direct contact by painting dissimilar metal with heavy coating of bituminous paint.

D. Hang doors and adjust hardware to achieve specified clearances and proper door operation.

E. Install door hardware as specified in Section 08 7100.

F. Coordinate installation of electrical connections to electrical hardware items.

3.04 FIELD QUALITY CONTROL

A. Provide services of FRP door manufacturer's field representative to observe for proper installation of system and submit report.

3.05 TOLERANCES

A. Tolerances: Install framing systems in accordance with the following tolerances:

1. Variation from Plane: Do not exceed 1/8 inch in 12 feet of length or 1/4 inch in any total length.
2. Offset from Alignment: Maximum offset from true alignment between 2 identical members abutting end to end in line shall not exceed 1/16 inch.
3. Diagonal Measurements: Maximum difference in diagonal measurements shall not exceed 1/8 inch.
4. Offset at Corners: Maximum out-of-plane offset of framing at corners shall not exceed 1/32 inch.

3.06 ADJUSTING

A. Adjust for smooth and balanced door movement.

3.07 CLEANING

A. Upon completion of installation, thoroughly clean door and frame surfaces in accordance with AAMA 609 & 610.

B. Do not use abrasive, caustic, or acid cleaning agents.

3.08 PROTECTION

A. Protect products of this section from damage caused by subsequent construction until Date of Substantial Completion.

B. Replace damaged or defective components that cannot be repaired to a condition indistinguishable from undamaged components.

END OF SECTION 08 1610

SECTION 08 3100 - ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall- and ceiling-mounted access units.

1.02 DEFINITIONS

A. Wet Areas: Includes the following:
   1. Exterior locations.
   2. Showers.
   3. Other areas as indicated.

B. Non-Wet Areas: Areas that are not indicated or listed as wet areas including, but not limited to, the following:
   1. Kitchens.
   2. Locker rooms.
   3. Toilet rooms.
   4. Janitor closets.

1.03 REFERENCE STANDARDS

A. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

C. ITS (DIR) - Directory of Listed Products; Current Edition.

D. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

C. Shop Drawings: Indicate exact position of each access door and/or panel unit.

D. Project Record Documents: Record actual locations of each access unit.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years documented experience.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel: Sheet complying with the following:
   1. All areas except wet areas: ASTM A1008/A1008M.
   2. Wet areas: ASTM A653/A653M Grade 33; A40 galvannealed.

2.02 WALL- AND CEILING-MOUNTED ACCESS UNITS

A. Manufacturers:
   1. Acudor; www.acudor.com.
   2. Babcock-Davis; www.babcockdavis.com.
   3. JL Industries/Activar Construction Products Group, Inc; www.activarcpg.com/jl-industries.
   4. Karp Associates, Inc; www.karpinc.com.
   5. Larsen’s Manufacturing Company: www.larsenmfg.com.
   6. Milcor / Hart & Cooley Inc; www.milcorinc.com.
   7. MIFAB, Inc.; www.mifab.com.
   8. Nystrom; www.nystrom.com.
   9. Substitutions: See Section 01 6000 - Product Requirements.

B. General:
   1. Factory fabricate doors and frames.
   2. Fully assemble units with corner joints welded, filled and ground flush; square and without rack or warp.
   3. Coordinate requirements with type of installation assembly being used for each unit.

C. Flush Access Doors with Exposed Flanges:
   1. Locations: Masonry.
   2. Material: Steel.
   3. Style: Exposed frame with door surface flush with frame surface.
      a. Masonry Mounting Criteria: Provide masonry anchor straps.
   4. Door Style: Single thickness with rolled or turned in edges.
   5. Doors: 14 gage, 0.0747 inch, minimum thickness.
   6. Frames: 16 gage, 0.0598 inch, minimum thickness.
   7. Steel Finish: Primed; manufacturer's standard rust-inhibitive powder coat.
   8. Door/Panel Size: As indicated on the drawings.
   9. Hardware:
      a. Hinges: Concealed, constant force closure spring type.
      b. Handle: No handle.
      c. Latch/Lock: Screw driver slot for quarter turn cam latch.
      d. Number of Locks/Latches Required: As recommended by manufacturer for size of unit.

D. Flush Access Doors with Concealed Flanges:
   1. Locations: Gypsum board.
   2. Material: Steel.
   3. Style: Concealed flange for drywall.
      a. Gypsum Board Mounting Criteria: Use drywall bead type frame.
   4. Door Style: Single thickness with rolled or turned in edges.
   5. Doors: 14 gage, 0.0747 inch, minimum thickness
   6. Frames: 16 gage, 0.0598 inch, minimum thickness.
   7. Steel Finish: Primed; manufacturer's standard rust-inhibitive powder coat.
   8. Door/Panel Size: As indicated on the drawings.
   9. Hardware:
      a. Hinges: Concealed, constant force closure spring type.
      b. Handle: No handle.
      c. Latch/Lock: Screw driver slot for quarter turn cam latch.
      d. Number of Locks/Latches Required: As recommended by manufacturer for size of unit.

E. Fire-Rated, Flush, Uninsulated, Access Doors with Exposed Flanges:
   1. Locations: Masonry.
   2. Material: Steel.
   3. Style: Exposed frame with door surface flush with frame surface.
      a. Masonry Mounting Criteria: Provide masonry anchor straps.
   4. Door Style: Single thickness with rolled or turned in edges.
   5. Doors: 16 gage, 0.0598 inch, minimum thickness
   6. Frames: 16 gage, 0.0598 inch, minimum thickness.
   7. Fire-Rating: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
      a. Provide products listed by ITS (DIR) or UL (FRD) as suitable for purpose indicated.
   8. Steel Finish: Primed; manufacturer's standard rust-inhibitive powder coat.
   9. Door/Panel Size: As indicated on the drawings.
   10. Hardware: Automatic closing, self-latching, with interior latch release.
      a. Hinges: Exposed, continuous piano hinge.
      b. Handle: No handle.
      c. Latch/Lock: Cylinder lock-operated cam latch, two keys for each unit.

d. Number of Locks/Latches Required: As recommended by manufacturer for size of unit.
e. Inside Latch Release: Mechanism that allows door/panel to be opened from inside.

F. Fire-Rated, Flush, Uninsulated, Access Doors with Concealed Flanges:
1. Locations: Gypsum board.
2. Material: Steel.
3. Style: Concealed flange for drywall.
a. Gypsum Board Mounting Criteria: Use drywall bead type frame.
4. Door Style: Single thickness with rolled or turned in edges.
5. Doors: 16 gage, 0.0598 inch, minimum thickness
6. Frames: 16 gage, 0.0598 inch, minimum thickness.
7. Fire-Rating: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
a. Provide products listed by ITS (DIR) or UL (FRD) as suitable for purpose indicated.
8. Steel Finish: Primed; manufacturer's standard rust-inhibitive powder coat.
9. Door/Panel Size: As indicated on the drawings.
10. Hardware: Automatic closing, self-latching, with interior latch release.
a. Hinges: Exposed continuous piano hinge.
b. Handle: No handle.
c. Latch/Lock: Cylinder lock-operated cam latch, two keys for each unit.
d. Number of Locks/Latches Required: As recommended by manufacturer for size of unit.
e. Inside Latch Release: Mechanism that allows door/panel to be opened from inside.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.
B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to proceeding with this work.
B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

A. Install units in accordance with manufacturer's instructions.
B. Install frames plumb and level in openings, and secure units rigidly in place.
C. Position units to provide convenient access to concealed equipment when necessary.

3.04 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 08 3100

SECTION 08 3323 - OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electric operators and control stations.

1.02 REFERENCE STANDARDS

A. ITS (DIR) - Directory of Listed Products; Current Edition.
B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
D. NEMA MG 00001 - Motors and Generators; 2024.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
G. UL (DIR) - Online Certifications Directory; Current Edition.
H. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general construction, electrical equipment, and component connections and details.
C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
    1. Include plans, elevations, sections, and mounting details.
    2. Include diagrams for power, signal, and control wiring.
D. Samples: Submit three slats, 6 inches long in size illustrating shape, color and finish texture.
E. Manufacturer's qualification statement.
F. Installer's qualification statement.
G. Field Quality Control: Submit field inspection reports.
H. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.
B. Installer Qualifications: Company specializing in performing work of type specified and with at least 5 years documented experience and approved by manufacturer.
C. Products Requiring Electrical Connection: Listed and classified by ITS (DIR), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for purpose specified.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide two year manufacturer warranty for defects in workmanship and materials from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Overhead Coiling Doors - Basis of Design: The design for each coiling door specified is based on the product named. Provide either the named product or a comparable product by one of the following:
    1. C.H.I. Overhead Doors; www.chiohd.com.
    2. Clopay Building Products: www.clopaydoor.com.
    3. CornellCookson, Inc.; www.cornelliron.com.

4. McKeon Door Company; www.mckeondoor.com.
5. Overhead Door Corp.; www.overheaddoor.com.
6. Raynor Door: www.raynor.com.
7. Wayne-Dalton; www.wayne-dalton.com.
8. Substitutions: See Section 01 6000 - Product Requirements.

2.02 COILING DOORS

A. Exterior Coiling Doors: Stainless steel slat curtain.
1. Basis of Design Product: Overhead Door Corp.; Model 625; www.overheaddoor.com.
2. Capable of withstanding positive and negative wind loads of 20 psf without undue deflection or damage to components.
3. Operation Cycles: Door components and operators capable of operating for not less than 20,000 cycles.
a. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
4. Sandwich slat construction with insulated core of foamed-in-place polyurethane insulation; minimum R-value of 7.5. Galvanized steel.
5. Nominal Slat Size: 2-1/2 inches wide x required length.
6. Finish: Manufacturer's standard powder coat finish; color to match Architect's sample.
a. Includes slats, hood enclosure, bottom bar, and guides.
7. Guide, Angles: Galvanized steel.
8. Bottom Bar or Angles: Galvanized steel.
9. Hood Enclosure: Manufacturer's standard; galvanized steel.
10. Electric operation.
11. Mounting: Surface mounted unless otherwise indicated on Drawings.

B. Non-Fire-Rated Interior Coiling Doors: galvanized steel slat curtain.
1. Basis of Design Product: Overhead Door Corp.; Model 610; www.overheaddoor.com.
2. Capable of withstanding positive and negative wind loads of 20 psf, without undue deflection or damage to components.
3. Operation Cycles: Door components and operators capable of operating for not less than 20,000 cycles.
a. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
4. Single Thickness Slats: Manufacturer's standard.
5. Nominal Slat Size: 2-1/2 inches wide x required length.
6. Finish: Manufacturer's standard powder coat finish; color to match Architect's sample.
a. Includes bottom bar and guides.
7. Guides, Angles: Primed steel.
8. Bottom Bar or Angles: Primed steel.
9. Hood Enclosure: Manufacturer's standard; stainless steel.
10. Electric operation.
11. Mounting: Surface mounted, unless otherwise indicated on Drawings.

2.03 ELECTRIC OPERATION

A. Operator, Controls, Actuators, and Safeties: Comply with UL 325; provide products listed by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.
1. Provide interlock switches on motor operated units.

B. Electric Operators:
1. Mounting: Side mounted.
2. Motor Enclosure:
a. Exterior Coiling Doors: NEMA MG 00001, Type 4; open drip proof.
b. Interior Coiling Doors: NEMA MG 00001, Type 1; open drip proof.
3. Motor Rating: 1/2 hp; continuous duty, unless otherwise recommended by overhead door manufacturer.
4. Motor Voltage: 120 volts, single phase, 60 Hz.
5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.

6. Controller Enclosure: NEMA EN 10250, Type 4.
7. Opening Speed: 12 inches per second.
8. Brake: Manufacturer's standard type, activated by motor controller.
9. Manual override in case of power failure.
10. Refer to Division 26 for electrical connections.

C. Automatic-Closing Device:
1. Equip each fire-rated door with an automatic-closing device and governor unit complying with NFPA 80, and an easily tested and reset release mechanism.
2. Release mechanism for motor-operated doors shall allow testing without mechanical release of the door.
3. Automatic-closing device shall be designed for activation by the following:
a. Building fire-detection, smoke-detection, and alarm systems.

D. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated; enclose terminal lugs in terminal box sized to comply with NFPA 70.

E. Control Station: Provide standard key-operated (Open-Close-Stop) momentary-contact control device for each operator conforming to UL 325.
1. 24 volt circuit.
2. Recess mounted, at location indicated on Drawings.
3. Entrapment Protection Devices: Provide sensing devices and safety mechanisms complying with UL 325.
a. Primary Device: Provide electric sensing edge as required with momentary-contact control device.

F. Safety Edge: Located at bottom of coiling door, full width, electro-mechanical sensitized type, wired to stop and reverse door direction upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with Division 26.

F. Complete wiring from disconnect to unit components.

G. Test and adjust controls and safety devices.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch.

C. Maximum Variation From Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 feet straight edge.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for field quality control and inspection.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Operate doors to confirm proper operation and door performance.
2. Test controls and safety devices.

3. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.
4. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80.
5. Prepare field inspection reports.

C. Repair or replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.05 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.06 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

3.07 DEMONSTRATION AND TRAINING

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

END OF SECTION 08 3323

SECTION 08 4313 - ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed storefront.
B. Insulated infill panels.
C. Aluminum doors and frames.

1.02 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.
C. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems; 2014.
D. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.
E. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
F. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
G. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
H. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
I. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
J. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
K. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
L. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
M. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.
N. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).
O. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors; 2002 (Reapproved 2018).
P. 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).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.
B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, and internal drainage details.
C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
   1. Include details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
D. Samples:
   1. Submit three samples for each finish specified, not less than 6 inches square or 6 inches long for linear components.
   2. Submit three samples of infill panels for each color and finish, not less than 6 inches square.
E. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
F. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
   1. Include storefront manufacturer's field representative's field observation reports.
G. Designer's qualification statement.
H. Manufacturer's qualification statement.
I. Installer's qualification statement.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
B. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least 5 years of documented experience.
C. Installer Qualifications: Company specializing in performing work of type specified and with at least 5 years of documented experience and approved by manufacturer.

1.06 MOCK-UP

A. See Section 01 4000 - Quality Requirements, for general requirements for mock-ups.
B. Provide minimum 4 by 8 feet mock-up including each component being used on the project. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
C. Locate on-site where directed by Architect; mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.
B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Provide five year manufacturer's warranty for defects in workmanship and materials.
C. Provide 20 year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermally Broken Storefront Products:

1. Basis of Design: Kawneer North American, an Arconic company; Trifab VG 451T Framing System: www.kawneer.com.
2. Other Manufacturers: Provide either the product identified as "Basis of Design" or one of the following equivalent products:
   a. CMI Architectural; Series 450TB: www.cmiarch.com.
   b. EFCO Corporation, an Apogee Enterprises, Inc. company; Series 433: www.efcocorp.com.
   c. Manko Window Systems, Inc.; 2450FS Series: www.mankowindowsystems.com.
   d. Tubelite Inc, an Apogee Enterprises, Inc. company; 14000 / 14000-I/O Series: www.tubeliteinc.com.
   e. YKK AP America, Inc.; YES 45 TU: www.ykkap.com.
   f. Substitutions: Refer to Section 01 6000 - Product Requirements.

B. Thermally Broken Storefront Products - High Performance:
1. Basis of Design: Kawneer North American, an Arconic company; Trifab 451UT Framing System: www.kawneer.com.
2. Other Manufacturers: Provide either the product identified as "Basis of Design" or one of the following equivalent products :
   a. EFCO Corporation, an Apogee Enterprises, Inc. company; Series 403X: www.efcocorp.com.
   b. Manko Window Systems, Inc.; 2450xpt Series: www.mankowindowsystems.com.
   c. Tubelite Inc, an Apogee Enterprises, Inc. company; TU24000 Series HP Thermal Storefront: www.tubeliteinc.com.
   d. YKK AP America, Inc.; YES 45 XT: www.ykkap.com.
   e. Substitutions: Refer to Section 01 6000 - Product Requirements.

C. Thermally Broken Storefront Products - Deep Profile:
1. Basis of Design: Kawneer North American, an Arconic company; EnCORE Framing System: www.kawneer.com.
   a. To be used for SSG.
2. Other Manufacturers: Provide either the product identified as "Basis of Design" or one of the following equivalent products:
   a. CMI Architectural: CTS Series: www.cmiarch.com.
   b. EFCO Corporation, an Apogee Enterprises, Inc. company; Series 960: www.efcocorp.com.
   c. Manko Window Systems, Inc.; 2600xpt Series: www.mankowindowsystems.com.
   d. Tubelite Inc, an Apogee Enterprises, Inc. company; T24650 Series: www.tubeliteinc.com.
   e. YKK AP America, Inc.; YES 600: www.ykkap.com.
   f. Substitutions: Refer to Section 01 6000 - Product Requirements.

D. Non-Thermally Broken Storefront Products:
1. Basis of Design: Kawneer North American, an Arconic company; Trifab VG 450 Framing System: www.kawneer.com.
2. Other Manufacturers: Provide either the product identified as "Basis of Design" or one of the following equivalent products:
   a. CMI Architectural; Series 450FG: www.cmiarch.com.
   b. EFCO Corporation, an Apogee Enterprises, Inc. company; Series 401: www.efcocorp.com.
   c. Manko Window Systems, Inc.; 450 Series: www.mankowindowsystems.com.
   d. Tubelite Inc, an Apogee Enterprises, Inc. company; 4500 Series: www.tubeliteinc.com.
   e. YKK AP America, Inc.; YES 40 FS: www.ykkap.com.
   f. Substitutions: Refer to Section 01 6000 - Product Requirements.

E. Swing Door Manufacturers:
1. Any of the manufacturers specified for storefront products.

F. Operable Vent/Sash Products:

1. Basis of Design: Kawneer North American, an Arconic company; GLASSvent: www.kawneer.com.
2. Other Manufacturers: Provide either the product identified as "Basis of Design" or one of the following equivalent products:
   a. CMI Architectural; 278 SSG Zero Sight-line Vents: www.cmiarch.com.
   b. EFCO Corporation, an Apogee Enterprises, Inc. company; WV410 SSG Vent: www.efcocorp.com.
   c. Tubelite Inc, an Apogee Enterprises, Inc. company; CVW 3700 Concealed Vent Window: www.tubeliteinc.com.
   d. YKK AP America, Inc.; YES SSG Vent Zero Sightline: www.ykkap.com.
   e. Substitutions: Refer to Section 01 6000 - Product Requirements.

G. Sun Screen Products:
1. Basis of Design: Kawneer North American, an Arconic company; Versoleil SunShade Outrigger System: www.kawneer.com.
2. Other Manufacturers: Provide either the product identified as "Basis of Design" or one of the following equivalent products:
   a. CMI Architectural; Or equal product: www.cmiarch.com.
   b. EFCO Corporation, an Apogee Enterprises, Inc. company; E Shade: www.efcocorp.com.
   c. Tubelite Inc, an Apogee Enterprises, Inc. company; Maxblock Sun Shades: www.tubeliteinc.com.
   d. YKK AP America, Inc.; ThermaShade System: www.ykkap.com.
   e. Substitutions: Refer to Section 01 6000 - Product Requirements.

H. Source Limitations: Obtain storefront systems, including swing doors, from one manufacturer.
1. Storefront systems shall be same manufacturer as that of curtain wall specified in Section 08 4413 - Glazed Aluminum Curtain Walls.

2.02 ALUMINUM-FRAMED STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
1. Thermal Breaks: Manufacturer's standard pour and debridge system.
2. Glazing Rabbet: For 1 inch insulating glazing, unless otherwise indicated.
3. Glazing Position: Centered (front to back).
4. Framing Face Width: 2 inches.
5. Framing Depth: 4-1/2 inches.
6. Finish: Superior performing organic coatings.
   a. Factory finish all surfaces that will be exposed in completed assemblies.
   b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
7. Finish Color: Custom color to match Architect's sample.
8. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
9. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
10. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
11. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
12. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.

13. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Performance Requirements
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
a. Design Wind Loads: Comply with requirements of ASCE 7 and as indicated on Drawings; not less than 25 lbf/ sq ft.
b. Member Deflection: Limit member deflection to 1/175 in any direction, with full recovery of glazing materials.
2. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.
3. Condensation Resistance Factor of Framing: 60, minimum, measured in accordance with AAMA 1503.
4. Overall U-value Including Glazing: 0.36 Btu/(hr sq ft deg F), maximum.
5. Design door frames to resist unauthorized entry when a 200 pound opening load acting upon the exterior door handle is applied to the locked door.

2.03 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.
1. Framing members for interior applications need not be thermally broken.
2. Glazing Stops: Flush.
3. Structurally Reinforced Members: Extruded aluminum with internal reinforcement of structural steel member.
a. Provide as required to comply with performance requirements.

B. Glazing: See Section 08 8000.

C. Infill Panels: Insulated, aluminum, with edges formed to fit glazing channel and sealed.
1. Total Nominal Thickness: 1 inch.
2. Overall Thickness: 1 inch.
3. Face Sheet: 0.32 inch thick smooth aluminum on 3 mm thick corrugated polypropylene substrate.
4. Core: Rigid polystyrene (EPS) insulation core with R-value of 4.
5. Back Sheet: 0.32 inch thick smooth aluminum on 3 mm thick corrugated polypropylene substrate.
6. Finish: Same as storefront.
7. Products:
a. Citadel Architectural Products; GlazeGuard 1000 WR+; www.citadelap.com.
b. Laminators, Inc.; Thermolite; www.laminatorsinc.com.
c. Mapes Panels LLC; Corelite: www.mapespanels.com.
d. Substitutions: Refer to Section 01 6000 - Product Requirements.

D. Swing Doors: Glazed aluminum.
1. Style: Wide style.
2. Thickness: 1-3/4 inches.
3. Top Rail: 5 inches wide.
4. Vertical Stiles: 5 inches wide.
5. Bottom Rail: 10 inches wide.
6. Glazing Stops: Square.
7. Finish: Same as storefront.

E. Sun Screens: Aluminum assemblies consisting of manufacturer's standard outrigger brackets, louvers, and fascia, designed for attachment to curtain wall with mechanical fasteners.
1. Design Criteria: Design and fabricate to resist the same loads as curtain wall system as well as the following loads without failure, damage, or permanent deflection:
a. Snow: As recommended by manufacturer for project location and climate.
b. Live: As recommended by manufacturer for project location and climate.

c. Thermal Movement: Plus/minus 1/8 inch, maximum.
2. Sun Screen Configuration:
a. Orientation: Horizontal.
b. Sizes: As indicated.
c. Projection from Wall: 36 inches unless otherwise indicated.
3. Outrigger Shape: Straight.
4. Fascia: Square.
5. Louvers:
a. Number: As recommended by manufacturer .
b. Shape: Airfoil.
c. Width: Manufacturer’s standard.
d. Mounting Angle: As recommended by manufacturer.
6. Finish: Same as curtain wall.

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).
B. Sheet Aluminum: ASTM B209/B209M.
C. Structural Steel Sections: ASTM A36/A36M; galvanized in accordance with requirements of ASTM A123/A123M.
D. Fasteners: Stainless steel.
E. Exposed Flashings: Aluminum sheet, 20 gauge, 0.032 inch minimum thickness; finish to match framing members.
F. Concealed Flashings: Stainless steel, 26 gauge, 0.0187 inch minimum thickness.
G. Glass and Glazing Accessories: As specified in Section 08 8000.

2.05 FINISHES

A. Superior Performing Organic Coatings System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch.
1. Color and Gloss: Two or three-coat custom color to match Architect's sample.
B. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.06 HARDWARE

A. For each door, include weatherstripping and sill sweep strip.
B. Other Door Hardware: See Section 08 7100.
C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.
D. Sill Sweep Strips: Resilient seal type, of neoprene; provide on all doors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.
B. Verify that storefront wall openings and adjoining flashings, water-resistive and/or air barrier seal materials are ready to receive work of this section.
1. Notify Architect immediately of any deficient locations.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.
B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
C. Provide alignment attachments and shims to permanently fasten system to building structure.
D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
E. Provide thermal isolation where components penetrate or disrupt building insulation.
F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
I. Install glass and infill panels in accordance with Section 08 8000 - Glazing.
J. Install door hardware as specified in Section 08 7100 - Door Hardware.
K. Coordinate installation of electrical connections to electrical hardware items.
L. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.
B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 FIELD QUALITY CONTROL

A. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.
B. See Section 01 4000 - Quality Requirements for general testing and inspection requirements.
C. Water-Spray Test: Provide water spray quality test of installed storefront components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.
    1. Perform a minimum of three tests in each designated area as directed by Architect.
    2. Conduct tests in each area prior to 10 percent, 50 percent, and 90 percent completion of this work.
D. Owner may engage an independent inspection agency to perform additional tests and inspections as follows:
    1. Provide field testing of installed storefront system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
        a. Perform a minimum of three tests in each designated area as indicated on drawings.
        b. Conduct tests in each area prior to 10 percent, 50 percent, and 90 percent completion of this work.
        c. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 8 psf.
            1) Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.
        d. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 6.20 psf.
            1) Maximum allowable rate of air leakage is 0.09 cfm/sq ft.
E. Repair or replace storefront components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.05 ADJUSTING

A. Adjust operating hardware and sash for smooth operation.

3.06 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.
B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.
C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.07 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 08 4313

SECTION 08 4500 - TRANSLUCENT WALL AND ROOF ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sandwich panels of translucent FRP skins with an internal aluminum grid.

1.02 RELATED REQUIREMENTS

1.03 ABBREVIATIONS

A. FRP: Fiberglass reinforced polymer.

1.04 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.

B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.

C. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.

D. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

E. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

I. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

J. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, panel configuration, internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, weep drainage network, expansion and contraction joint locations and details, and required field welding.

D. Samples:

1. Framing: Submit three samples for each aluminum finish specified, not less than 6 inches square or 6 inches long for linear components.
2. Translucent Panels: Submit three samples for each color and pattern specified, not less than12 inches square

E. Design Data: Show structural and physical characteristics, engineering calculations, and dimensional limitations.

F. Test Reports: Substantiating engineering data, test results of previous tests by independent laboratory demonstrating compliance with performance requirements.

G. Field Quality Control Reports: Provide manufacturer's field representative's observation reports.

H. Designer's Qualification Statement.
I. Manufacturer's Qualification Statement.
J. Installer's Qualification Statement.
K. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.07 QUALITY ASSURANCE

A. Perform work in accordance with AAMA CW-DG-1.
B. Designer Qualifications: Design structural support framing components under direct supervision of Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 5 years of documented experience.
D. Installer Qualifications: Company specializing in performing the work of this section with at least 5 years of documented experience and approved by manufacturer.

1.08 MOCK-UP

A. Locate where directed.
B. Mock-up may remain as part of the Work.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Handle work of this section in accordance with AAMA CW-10.
B. Protect prefinished aluminum surfaces with wrapping; do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.
   1. Puncture wrappings at ends for ventilation.

1.10 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F.
B. Maintain this minimum temperature during and after installation of sealants.

1.11 WARRANTY

A. See Section 001 7800 - Closeout Submittals, for additional warranty requirements.
B. System warranty: Provide written warranty signed by manufacturer, agreeing to repair or replace work which exhibits defects in materials or workmanship. Defects are defined to include uncontrolled leakage of water, abnormal aging or deterioration, or failure to perform as required.
   1. Warranty period: 5 years form date of Substantial Completion.
C. Translucent Glazing Material Warranty: Provide written warranty signed by manufacturer, agreeing to repair or replace glazing materials which exhibit defects in materials or workmanship. Defects are defined to include fiberbloom, delamination of coating from exterior sheet, or more than 15 percent discoloration.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Translucent Wall and Roof Assemblies Manufacturers:
   1. Kalwall; 2-3/4 inch Wall System, thermally broken: www.kalwall.com/#sle.
   2. Danpal 2 3/4 inch Danpantherm K7; Danpal North America; PH (312) 724-8166.
   3. Substitutions: Not permitted.

2.02 PERFORMANCE REQUIREMENTS

A. System Design: Design and size components to withstand dead loads and live loads caused by snow, hail, and positive and negative wind loads acting on plane of panel without damage or permanent set.
   1. Design Loads: Calculate in accordance with ASCE 7 and as indicated on Drawings; not less than 25 lbf/ sq ft.

2. Measure performance in accordance with ASTM E330/E330M, using test load of 1.5 times the design wind pressure and 10 second duration of maximum load.

B. Seismic Loads: Design and size components to withstand seismic loads and sway displacement as calculated in accordance with applicable code.

C. Deflection: Limit mullion deflection to L/120 or 3/4 inch, whichever is less, with full recovery of glazing materials.

D. System Assembly: Accommodate without damage to system, components or deterioration of seals; movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; deflection of structural support framing, and tolerance of supporting components.

E. Light Transmission: 26 percent.

F. Thermal Resistance of Panels: U-Value of 0.23.

G. Air Infiltration: Limit air infiltration through assembly to 0.06 cu ft/min sq ft of sloped glazed area, measured at a reference differential pressure across assembly of 6.24 psf as measured in accordance with ASTM E283.

H. Condensation Resistance Factor (CRF): Minimum of 70 when measured in accordance with AAMA 1503.

I. Water Leakage: None, when measured in accordance with ASTM E331 at a test pressure difference of 15 lbf/sq ft.

J. Expansion/Contraction: System to provide for expansion and contraction within system components caused by a cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components.

K. System Internal Drainage: Drain water entering joints, condensation occurring in framing system, or migrating moisture occurring within system, to the exterior by a weep drainage network.

L. Fabricate to prevent vibration harmonics, thermal movement transmitted to other building elements, and loosening, weakening, or fracturing of attachments or components of system.

2.03 SYSTEMS

A. Sandwich Panel Translucent Wall and Roof Systems: Structurally reinforced translucent panel assemblies, with self-supporting panel framing, insulation, and internal grid of stiffener battens.

2.04 ASSEMBLIES

A. Sandwich Panel Assemblies: Bonded to both sides of structural extruded aluminum grid with manufacturer's standard pattern; exposed surfaces of exterior sheet chemically and permanently treated to protect against surface erosion and extreme weather conditions; polyvinyl fluoride film coated.

1. Sandwich Panel Insulation: Manufacturer's standard translucent type, with substantive thermal and acoustical properties.

2.05 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Sheet Aluminum: ASTM B209 (ASTM B209M).

C. Fasteners: Stainless steel.

2.06 COMPONENTS

A. Panels: Translucent panels bonded to both sides of thermally broken structural extruded aluminum grid of pattern as indicated; exposed surfaces of exterior sheet chemically and permanently treated to protect against surface erosion and extreme weather conditions; exposed surface of interior sheets with fire retardant having flame spread index (FSI) of 25 and smoke developed index (SDI) of 250 in accordance with ASTM E84.

1. Panel Thickness: 2-3/4 inches.
2. Facing Sheets: Translucent.

a. Exterior Face: 0.070 inch thick, fiberglass reinforced polymer (FRP).
1) Color: Crystal, semi-gloss finish.
b. Interior Face: 0.045 inch thick, fiberglass reinforced polymer (FRP).
1) Color: White, matte finish.
3. Insulating Infill Material: Manufacturer's standard fiberglass batts.
4. Grid Pattern: Shoji, 12 inch by 24 inch grid pattern.

B. Perimeter Framing, Battens, Cover Strips, Cover Plates, and Integral Flashings: Extruded aluminum, to suit location and application; sized to rigidly retain panels in place.
C. Sill Flashings: 0.04 inch thick aluminum, matching finish, secured with concealed fastening method.
D. Weather Seals: To suit application; non-bleeding; non-staining.
E. Sealant for Within Translucent Assembly: As required by manufacturer.

2.07 FABRICATION

A. Fabricate system components with minimum clearances and shim spacing around perimeter of assembly, and ensure proper installation and dynamic movement of perimeter seals.
B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.
C. Prepare components to receive fabricated anchor devices.
D. Locate fasteners and attachments to ensure concealment from view.
E. Reinforce framing members for external imposed loads.

2.08 FINISHES

A. Superior Performing Organic Coatings System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch.
1. Color and Gloss: Two or three-coat custom color to match Architect's sample.
B. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.
B. Verify wall openings and adjoining air barrier and vapor retarder materials are ready to receive work of this section.

3.02 INSTALLATION

A. Install translucent panel system in accordance with manufacturer instructions.
B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
C. Provide alignment attachments and shims to permanently fasten system to building structure.
D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances and align with adjacent work.
E. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 0.5 inches per 100 ft, whichever is less.
B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.
C. Sealant Space Between Panel System Members and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.04 FIELD QUALITY CONTROL

A. Provide the services of the manufacturer's field representative to observe installation and make report.

B. Owner may engage an independent inspection agency to perform tests and inspections.

1. Independent inspection will be provided under provisions of Section 01 4000 - Quality Requirements.
2. Inspection will monitor quality of installation and glazing.
3. Test installed assemblies for water leakage in accordance with AAMA 501.2.
4. Replace assembly components that have failed field testing and retest until performance is satisfactory.

3.05 CLEANING

A. Remove protective material from prefinished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths; remove dirt from corners and wipe surfaces clean.

3.06 PROTECTION

A. Protect finished work from damage until Date of Substantial Completion.

END OF SECTION 08 4500

SECTION 08 8000 - GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Monolithic glazing.
B. Insulating glass.
C. Glazing compounds.

1.02 REFERENCE STANDARDS

A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
D. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2022.
E. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
F. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
G. ASTM C1036 - Standard Specification for Flat Glass; 2021.
H. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
I. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2019.
J. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
K. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
L. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2024.
M. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
N. GANA (GM) - GANA Glazing Manual; 2022.
O. GANA (SM) - GANA Sealant Manual; 2008.
P. GANA (LGRM) - Laminated Glazing Reference Manual; 2019.
Q. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
R. IGMA TB-3001 - Guidelines for Sloped Glazing; 2001.
S. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (Reaffirmed 2016).
T. NFPA 251 - Standard Methods of Tests of Fire Resistance of Building Construction and Materials - 2006.
U. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.
V. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.
W. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2023.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by each of the affected installers.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data on Glazing. Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.

C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
D. Samples: Submit three samples 12 by 12 inch in size for each glass type.
   1. Non-insulated types may be 4 by 4 inches in size.
E. Certificate: Certify that products of this section meet or exceed specified requirements.
F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with GANA (GM), GANA (SM), GANA (LGRM), IGMA TM-3000, and IGMA TB-3001 for glazing installation methods.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.
C. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years documented experience.

1.06 MOCK-UPS

A. See Section 01 4000 - Quality Requirements for additional requirements.
B. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Install glazing in mockups specified in:
      a. Section 08 4435 - Protective Framed Glazing Assemblies.
      b. Section 08 4313 - Aluminum-Framed Storefronts.
      c. Section 08 4413 - Glazed Aluminum Curtain Walls.
      d. Section 08 5113 - Aluminum Windows.
      e. Section 08 6300 - Metal-Framed Skylights.
C. Mock-ups may remain as part of the Work.

1.07 FIELD CONDITIONS

A. Do not install glazing when ambient temperature is less than 40 degrees F.
B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Insulating Glass Units: Provide a ten (10) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.
C. Laminated Glass: Provide a ten (10) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.
D. Coated Glass: Provide a ten (10) year manufacturer warranty to include coverage for peeling, cracking, and other indications of deterioration in coating, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Float Glass Manufacturers:
   1. Guardian Glass, LLC: www.guardianglass.com.
   2. Pilkington North America Inc: www.pilkington.com.
   3. Viracon, Inc: www.viracon.com.
   4. Vitro Architectural Glass (formerly PPG Industries, Inc.): www.vitroglazings.com.
B. Laminated Glass Manufacturers:
   1. Any of the manufacturers specified for float glass.
C. Insulating Glass Manufacturers:
   1. Any of the manufacturers specified for float glass.

2. All lites of an Insulating Glazing Unit shall be by one manufacturer. Do not mix manufacturers within IGUs.

D. Source Limitations: Obtain Float Glass and Low Iron Float Glass from one manufacturer. Obtain Fire Rated Glass from one manufacturer.

2.02 PERFORMANCE REQUIREMENTS

A. Exterior Glazing Assemblies:
1. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
a. Design Pressure: Calculated in accordance with ASCE 7 applicable codes, and as indicated on Drawings..
b. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
1) Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 the short side length or 1 inch, whichever is less.
c. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
d. Glass thicknesses listed are minimum.
2. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
a. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
b. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
c. Solar Optical Properties: Comply with NFRC 300 test method.

B. Probability of Breakage: Design glass for a probability of breakage not greater than 0.008 (8 lites per 1000) for glass not more than 15 degrees from vertical.

C. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Insulating Glass:
1. Insulating Glass Certification Program: Provide insulating glass units that are certified by the Insulating Glass Certification Council (IGCC).
a. Provide permanent markings with appropriate certification label of IGCC on either the spacer or one lite of each insulated unit.

E. Safety Glazing:
1. Complies with ANSI Z97.1 and 16 CFR 1201; test requirements for Class A/Category II.
2. Markings for Safety Rated Glazing: Provide permanent markings on safety-rated glazing in compliance with applicable safety glazing standards, ICC (IBC), local building code, and authorities having jurisdiction.

F. Glass Thickness: Indicated glass thicknesses are minimums. Provide glass that complies with performance requirements and load designs, and is not less than the thickness indicated.

G. Glass Strength:
1. Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with performance requirements.
2. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with performance requirements.

H. Glass Distortion Tolerances:
1. Roller Wave: Maximum 0.003 (0.076 mm) from peak to valley within the main body of the sheet and maximum 0.008 (0.2 mm) within 10.5 inches of a leading or trailing edge.

2. Localized Warp: Maximum 0.03 inch (0.8 mm) over any 12 inch (305 mm) span, but limited to 0.31 inch (8 mm).

2.03 FLOAT GLASS

A. Float Glass: Provide float glass based glazing unless otherwise indicated.
   1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
   2. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
   3. Kind FT - Fully Tempered Type: Complies with ASTM C1048.

2.04 LAMINATED GLASS

A. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
   1. Unless otherwise indicated laminate glass shall consist of two plies of clear annealed float glass with a polyvinyl butyral interlayer.
      a. Minimum Thickness of Each Glass Ply: 1/8 inch (3 mm), unless otherwise indicated.
      b. Polyvinyl Butyral (PVB) Interlayer: 0.030 inch thick, minimum, unless otherwise indicated.
         1) Interlayer Color: Clear, unless otherwise indicated.

2.05 INSULATING GLASS

A. Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.

B. General: Unless otherwise noted, Insulating Glass Unit Types shall comply with the following:
   1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
   2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO.
      a. Low-E Coating:
         1) Basis-of-Design Product: Vitro Architectural Glass (formerly PPG Industries, Inc. ; Solarban 70, or a comparable product from any of the manufacturers specified for float glass.
   3. Perimeter Spacer: Warm-edge spacer.
      a. Manufacturer's standard low conductivity polymer, stainless steel, or hybrid material.
         1) Spacer Color: Gray.
         2) Spacer Width: As required for specified insulating glass unit.
         3) Products:
            (a) Quanex IG Systems, Inc; Super Spacer Premium Enhanced: www.quanex.com.
            (b) Technoform Glass Insulation; TGI-Spacer: www.glassinsulation.us.
            (c) Viracon, Inc; VTS (Viracon Thermal Spacer): www.viracon.com.
            (d) Vitro Architectural Glass (Formerly PPG); Intercept Spacer System: www.vitroglazings.com.
            (e) Substitutions: Refer to Section 01 6000 - Product Requirements.
   4. Edge Seal:
      a. Dual-Sealed System: Provide polyisobutylene or acrylic adhesive or spacer manufacturer's standard sealant as primary seal applied between spacer and glass panes, and butyl sealant as secondary seal applied around perimeter.
      b. Color: Black.
   5. Purge interpane space with dry air, hermetically sealed.

2.06 GLAZING COMPOUNDS

A. Butyl Sealant: Solvent-based; ASTM C1311; single component, nonsag, butyl sealant.
   1. Product:
      a. Pecora Corp.; BC-158: www.pecora.com.
      b. Tremco, Inc.; Butyl Sealant: www.tremcosealants.com.
      c. Substitutions: Refer to Section 01 6000 - Product Requirements.

B. General Glazing Silicone Sealant: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 25 or 50, Use NT.

1. Products:
   a. Dow Corning Corporation; 899 Silicone Glazing Sealant: www.dowcorning.com.
   b. GE/Momentive Performance Materials, Inc: SCS2800 SilGlaz II: www.siliconeforbuilding.com
   c. Pecora Corporation: 896: www.pecora.com.
   d. Tremco, Inc.: Spectrem 2: www.tremcosealants.com.
   e. Substitutions: Refer to Section 01 6000 - Product Requirements.
2. Color: Black.

2.07 ACCESSORIES

A. Setting Blocks: EPDM or neoprene, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.

B. Spacer Shims: EPDM or neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.

C. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
   1. Width: As required for application.
   2. Thickness: As required for application.

D. Glazing Gaskets and Splines: Resilient EPDM or polyvinyl chloride extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

E. Glazing Clips: Manufacturer's standard type.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

C. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.

B. Use one or more of the specified glazing methods as recommended by GANA, glass manufacturer, and installer, and as required to comply with performance requirements.

C. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

D. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.

E. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.

F. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.

G. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.04 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 INSTALLATION - DRY GLAZING METHOD (TAPE AND GASKET SPLINE GLAZING)

A. Application - Exterior Glazed: Set glazing infills from the exterior of the building.
B. Cut glazing tape or spline to length; install on glazing pane. Seal corners by butting tape and sealing junctions with butyl sealant.
C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
D. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
E. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
F. Carefully trim protruding tape with knife.

3.06 INSTALLATION - DRY GLAZING METHOD (TAPE AND TAPE)

A. Application - Interior Glazed: Set glazing infills from the interior of the building.
B. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch above sight line.
C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
D. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
E. Place glazing tape on free perimeter of glazing in same manner described above.
F. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
G. Carefully trim protruding tape with knife.

3.07 CLEANING

A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
B. Remove nonpermanent labels immediately after glazing installation is complete.
C. Clean glass and adjacent surfaces after sealants are fully cured.
D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.08 PROTECTION

A. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

3.09 GLASS SCHEDULE

A. GL-1: Clear monolithic glass.
   1. Clear annealed float glass.
   2. Minimum Thickness: 1/4 inch (6 mm).
B. GL-2: Clear heat-strengthened laminated glass.
   1. Clear laminated safety glass.

2. Minimum Thickness: 1/4 inch (6 mm).
3. Safety glazing required.

C. GL-3: Low-E-coated, Clear tempered insulating glass.
1. Overall Unit Thickness: 1 inch.
2. Outdoor Lite: Clear tempered float glass.
   a. Minimum Thickness: 1/4 inch (6 mm).
3. Airspace:
   a. Width: 1/2 inch.
   b. Interspace Content: Air.
4. Indoor Lite: Clear tempered float glass.
   a. Minimum Thickness: 1/4 inch (6 mm).
   b. Low-E Coating: On 3rd surface.
5. Performance:
   a. Visible Light Transmittance: 32 percent minimum.
   b. Solar Heat Gain Coefficient: 0.24 maximum.

D. GL-4: Low-E Coated, Clear laminated heat-strengthened insulating glass.
1. Overall Unit Thickness: 1 inch.
2. Outdoor Lite: Clear heat-strengthen laminated float glass.
   a. Minimum Thickness: 1/4 inch (6 mm).
3. Airspace:
   a. Width: 1/2 inch.
   b. Interspace Content: Air.
4. Indoor Lite: Clear heat-strengthen laminated float glass.
   a. Minimum Thickness: 1/4 inch (6 mm).
   b. PVB Interlayer Color: Clear.
   c. Low-E Coating: On 3rd surface.
5. Performance:
   a. Winter Nighttime U-Factor: 0.28 maximum.
   b. Visible Light Transmittance: 32 percent minimum.
   c. Solar Heat Gain Coefficient: 0.24 maximum.

E. FRGL-1: 60 minute fire-protection-rated glazing.
1. Specialty tempered float glass.
2. Thickness: 3/4 inch.
3. Fire Rating: 60 minutes.

END OF SECTION 08 8000

SECTION 08 9100 - LOUVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Louvers, frames, and accessories.

1.02 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
B. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices; 2021, with Editorial Revision (2022).
C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
E. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.
C. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, and tolerances; head, jamb and sill details; blade configuration, screens, blank-off areas required, and frames.
D. Samples: Submit three samples 4 by 4 inches in size illustrating finish and color of exterior and interior surfaces.
E. Test Reports: Independent agency reports showing compliance with specified performance criteria.
F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum 5 years of documented experience.
B. Installer Qualifications: Company specializing in performing work of type specified and with at least 5 years of documented experience.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturer's warranty against distortion, metal degradation, and connection failures of louver components.
    1. Finish: Include twenty year coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Louvers - Drainable Blades:
    1. The Airolite Company, LLC; Model K6744: www.airolite.com.
    2. Arrow United Industries; Model EA-425-DD: www.arrowunited.com.
    3. Construction Specialties, Inc.; Model A4097: www.c-sgroup.com.
    4. Greenheck Fan Corporation; Model ESD-435: www.greenheck.com.
    5. Industrial Louvers, Inc.; Model 458XP: www.industriallouvers.com.
    6. Ruskin; Model ELF375DX: www.ruskin.com.
    7. Substitutions: See Section 01 6000 - Product Requirements.
B. Louvers - Nondrainable Blades:
    1. The Airolite Company, LLC; Model K609: www.airolite.com.

2. Arrow United Industries; Model EA-410: www.arrowunited.com.
3. Construction Specialties, Inc.; Model A4080: www.c-sgroup.com.
4. Greenheck Fan Corporation; Model ESJ-401: www.greenheck.com.
5. Industrial Louvers, Inc.; Model 450XP: www.industriallouvers.com.
6. Ruskin; Model ELF375X: www.ruskin.com.
7. Substitutions: See Section 01 6000 - Product Requirements.

2.02 LOUVERS

A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified in accordance with AMCA 511.
   1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf without damage or permanent deformation.
   2. Beginning point of water penetration at 0.01 oz/sq ft is 850 fpm, minimum.
   3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
   4. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers.
B. Stationary Louvers: Horizontal blade, extruded aluminum construction, with concealed intermediate mullions.
   1. Free Area: 50 percent, minimum.
   2. Blades: Drainable.
   3. Frame: 4 inches deep, channel profile; corner joints mitered.
   4. Aluminum Thickness: Frame 12 gage, 0.081 inch minimum; blades 12 gage, 0.081 inch minimum.
   5. Aluminum Finish: Superior performing organic coatings; finish welded units after fabrication.

2.03 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T5 or T6 temper.

2.04 FINISHES

A. Superior Performing Organic Coatings System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of aluminum extrusion and panels surfaces having minimum total dry film thickness (DFT) of 1.2 mils, 0.0012 inch.
   1. Color: Two or three-coat custom color to match Architect's sample.

2.05 ACCESSORIES

A. Blank-Off Panels: Aluminum face and back sheets, polyisocyanurate foam core, 2 inch thick, painted black on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.
B. Screens: Frame of same material as louver, with mitered and welded corners; removable, screw attached; installed on inside face of louver frame.
C. Bird Screen: Interwoven wire mesh of steel, 14 gage, 0.0641 inch diameter wire, 1/2 inch open weave, square design.
D. Insect Screen: 18 x 16 size aluminum mesh.
E. Fasteners and Anchors: Stainless steel.
F. Flashings: Sheet aluminum, formed to required shape, single length in one piece per location.
   1. Comply with ASTM B209.
   2. Minimum Thickness: 0.032 inches thick.
   3. Includes, but is not limited to, the following:
      a. Extended sill with drip edge.
G. Sealant for Setting Sills and Sill Flashing: Non-curing butyl type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared openings and flashings are ready to receive this work and opening dimensions are as indicated on shop drawings.

3.02 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions.
B. Install louvers level and plumb.
C. Set sill members and sill flashing in continuous bead of sealant.
D. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
E. Secure louver frames in openings with concealed fasteners.
F. Coordinate with installation of mechanical ductwork.

3.03 CLEANING

A. Strip protective finish coverings.
B. Clean surfaces and components.

END OF SECTION 08 9100

SECTION 09 0561 - COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing of concrete floor slabs for moisture and alkalinity (pH).
B. Remedial floor coatings for concrete floor slabs.

1.02 PRICE AND PAYMENT PROCEDURES

A. Remedial Floor Coatings.
   1. Contractor shall perform all required remediation of concrete floor slabs;
      a. Contractor shall perform the work at no additional cost to Owner where moisture vapor reduction admixture (MVRA) was required as part of the concrete mix design.
      b. Where remedial floor coating was indicated, Contractor shall perform the work at no additional cost to Owner
      c. Where a moisture vapor reduction admixture (MVRA) was not required and at floor slabs where remedial floor coatings were not indicated, a contract modification will be issued based upon the following:
         1) Unit pricing as specified in Section 01 2200 - Unit Prices.
         2) Contingency allowance as specified in Section 01 2100 - Allowances.
         3) No unit pricing or allowances were provided; Contractor shall record and submit written records of costs, including material quantities used, number of labor hours used, and total area, in square feet, of remediated concrete.

1.03 REFERENCE STANDARDS

A. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
B. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.
C. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
D. ASTM F3010 - Standard Practice for Two-Component Resin Based Membrane-Forming Moisture Mitigation Systems for Use Under Resilient Floor Coverings;2018.
E. ICRI 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair; 2013.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.05 SUBMITTALS

A. Testing Reports:
   1. Description of areas tested; include floor plans and photographs if helpful.
   2. Summary of conditions encountered.
   3. Moisture and alkalinity (pH) test reports.
   4. Copies of specified test methods.
   5. Submit reports to Architect.
   6. Submit reports not more than two business days after conclusion of testing.
B. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.
   1. Manufacturer's statement of compatibility with types of flooring, including adhesives, applied over remedial product.
   2. Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.

1.06 QUALITY ASSURANCE

A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.
   1. At Contractor's option, tests may be performed by the Contractor.
B. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
C. Remedial Coating Installer Qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer, and at least 5 years' experience installing moisture emission coatings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect products in accordance with manufacturer’s instructions and recommendations.
B. Deliver materials in manufacturer’s packaging; include installation instructions.
C. Keep materials from freezing.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.
B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 PRODUCTS

2.01 MATERIALS

A. Remedial Floor Coating: Single- or multi-layer coating intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
   1. Material: Comply with ASTM F3010.
   2. Thickness: As required for application and in accordance with manufacturer's installation instructions.
   3. Provide resistance to up to 95 percent relative humidity and 15 pounds moisture vapor transmission.
   4. Provide resistant to alkalinity (pH) level of pH 14.
   5. Products:
      a. Maxxon Corporation; Aquafin Vaportight Coat-SG4: www.maxxon.com.
      b. Schonox, HPS North America, Inc.; MR-18: www.hpsubfloors.com.
      c. Specialty Products Group; Vapor Lock 0/0: www.spggogreen.com.
      d. Spray-Lock; SCP 578: www.concreteprotection.com.
      e. Tnemec Company, Inc; Epoxoprime MVT Series 208 : www.tnemec.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

A. Follow recommendations of testing agency.
B. Perform following operations in the order indicated:
   1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
      a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
      b. Removal of existing floor covering.
   2. Preliminary cleaning.
   3. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.

4. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
5. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
6. Patching, smoothing, and leveling, as required.
7. Other preparation specified.
8. Adhesive bond and compatibility test.
9. Protection.

C. Remediations:
1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
2. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.02 REMOVAL OF EXISTING FLOOR COVERINGS

A. Dispose of removed materials in accordance with local, State, and federal regulations and as specified.

3.03 PRELIMINARY CLEANING

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

3.04 MOISTURE VAPOR EMISSION TESTING

A. Moisture vapor emission testing for concrete floor slabs.
1. Test where adhesive applied floor finishes are to be installed, and where indicated.
a. Including:
1) Wood gymnasium flooring.
2) Wood stage flooring.
3) Epoxy matrix terrazzo flooring.

B. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

C. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

D. Test in accordance with ASTM F1869 and as follows.

E. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.

F. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.
1. After remedial floor coating has been applied, perform the test again.
a. If test values exceed floor covering manufacturer's limits, notify Architect immediately and await further instructions. Do not install finish flooring until authorized.

G. Report: Report the information required by the test method.

3.05 INTERNAL RELATIVE HUMIDITY TESTING

A. Internal relative humidity testing for concrete floor slabs.
1. Test where adhesive applied floor finishes are to be installed, and where indicated.
a. Including:
1) Wood gymnasium flooring.

2) Wood stage flooring.

B. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

C. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

D. Test in accordance with ASTM F2170 Procedure A and as follows.

E. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.

F. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

1. After remedial floor coating has been applied, perform the test again.
   a. If test values exceed floor covering manufacturer's limits, notify Architect immediately and await further instructions. Do not install finish flooring.

G. Report: Report the information required by the test method.

3.06 ALKALINITY TESTING

A. Alkalinity testing for concrete floor slabs.

1. Test where adhesive applied floor finishes are to be installed, and where indicated.

B. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

C. The following procedure is the equivalent of that described in ASTM F710, repeated here for the Contractor's convenience.

1. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.
2. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (pH) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (pH) reading.
3. Use of a digital pH meter with probe is acceptable; follow meter manufacturer's instructions.

D. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

1. After remedial floor coating has been applied, perform the test again.
   a. If test values exceed floor covering manufacturer's limits, notify Architect immediately and await further instructions. Do not install finish flooring until authorized.

E. Report: Report test results.

3.07 ADHESIVE BOND AND COMPATIBILITY TESTING

A. Comply with requirements and recommendations of floor covering manufacturer.

B. Apply remedial floor coating to concrete slabs that fail one or more of the following tests:

1. Moisture vapor emission testing .
2. Internal relative humidity testing.
3. Alkalinity testing.

C. Install in accordance with remedial floor coating manufacturer's instructions and as follows:

1. Shot blast or mechanically abrade concrete surfaces to meet surface profile of 3 to 4 per ICRI 310.2R; acid etching is not permitted.
2. Vacuum and clean slab to remove all dust, dirt, and debris.
3. Apply one to two coats of remedial floor coating as recommended by remedial floor coating manufacturer.

3.08 PROTECTION

A. Cover prepared floors with building paper or other durable covering.

END OF SECTION 09 0561

SECTION 09 2216 - NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal non-load-bearing interior partition, ceiling, and soffit framing.
B. Shaft wall framing.
C. Suspension systems for interior ceilings and soffits.
D. Framing accessories.

1.02 REFERENCE STANDARDS

A. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
D. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2024.
E. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
F. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2023.
G. ASTM C955 - Standard Specification for Cold-Formed Steel Structural Framing Members; 2018, with Editorial Revision.
H. ASTM D3575 - Standard Test Methods for Flexible Cellular Materials Made From Olefin Polymers.
I. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
J. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
K. ASTM E413 - Classification for Rating Sound Insulation; 2022.
L. ASTM F1941/F1941M - Standard Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric; 2016.
M. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs; 2022.
N. ASTM F594 - Standard Specification for Stainless Steel Nuts; 2022.
O. GA-216 - Application and Finishing of Gypsum Panel Products; 2024.
P. GA-600 - Fire Resistance and Sound Control Design Manual; 2024.
Q. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
R. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.
S. UL (FRD) - Fire Resistance Directory; Current Edition.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Shop Drawings:
   1. Indicate component details, control joints, stud layout, framed openings, anchorage to structure, acoustic details, type and location of fasteners, and accessories.
   2. Describe method for securing studs to tracks, splicing, and for blocking and reinforcement of framing connections.
   3. Coordinate with Section 09 2900
C. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.

D. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
E. Manufacturer's Qualification Statement.
F. Installer's Qualification Statement.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Framing, Shaft Wall Framing, Connectors, and Accessories:
1. ClarkDietrich Building Systems: www.clarkdietrich.com.
2. Jaimes Industries Inc.: www.jaimesind.com.
3. MarinoWARE: www.marinoware.com.
4. MBA Building Supplies, Inc.: www.mbastuds.com.
5. State Building Products; www.statebp.com.
6. The Steel Network, Inc: www.SteelNetwork.com.
7. Telling Industries; www.buildstrong.com.
8. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

A. Provide completed assemblies complying with ASTM C840 and GA-216.
B. Fire-Rated Assemblies: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 and as follows:
1. Provide construction equivalent to one of the following:
a. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).
b. Gypsum Association File Numbers: Provide construction complying with requirements of GA-600 for the particular assembly.
C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
D. Shaft Walls: Provide completed assemblies with the following characteristics:
1. Comply with requirements of Fire-Rated Assemblies.
2. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
a. Air Pressure Within Shaft: Sustained loads of 7.5 lbf/sq ft with maximum mid-span deflection of L/240; unless otherwise indicated.
b. Acoustic Attenuation: STC of 40-44 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90; unless otherwise indicated.
E. Horizontal Deflection: For wall assemblies, limit maximum deflection of wall framing to L/240 at 5 psf .
1. Exception: Limit deflection of walls to receive hard tile surfaces to L/360 at 5 psf.
F. Protective Coatings: Equivalent (EQ) coatings are not acceptable; products shall be hot-dip galvanized as indicated.
G. Embossed (equivalent thickness) steel framing products are not acceptable; unless products are in steel thicknesses indicated.

2.03 FRAMING MATERIALS

A. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated.

1. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized.
2. Minimum Metal Thickness: 0.030 inch (20 gage).
3. Framing Depths: As indicated.
4. Profiles:
   a. Studs: C shaped with flat or formed webs.
   b. Runners: U shaped, sized to match studs.
      1) Where indicated or required, provide slip-type head joints using slotted deflection track.
   c. Ceiling Channels: C shaped.
   d. Furring: Hat-shaped sections, minimum depth of 7/8 inch.

B. Slotted Deflection Track: Provide galvanized sheet steel track with slotted holes in flanges for mechanical anchorage of studs that accommodate deflection; provide screws and anti-friction bushings. Slotted connections prevent stud rotation without use of lateral bracing and maintains structural performance of partition.
1. Provide at partition heads to structure connections.
2. Shall prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above
3. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
4. Comply with ASTM C645 and ASTM C754.
5. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized.
6. Minimum Metal Thickness: Same material thickness as studs.
7. Track Depth: Matching studs.
8. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
   a. At Contractor's option, provide the following:
      1) Slotted Deflection and Firestop Track: Similar to standard slotted deflection track specified, but includes intumescent strip factory-applied to track flanges or web that expands when exposed to heat or flames to provide a perimeter joint seal.
         (a) Products:
            (1) ClarkDietrich Building Systems; BlazeFrame Firestop Deflection Track : www.clarkdietrich.com.
            (2) MarinoWARE; FAS Track 1000: www.marinoware.com.
            (3) Substitutions: See Section 01 6000 - Product Requirements.

C. Preformed Top Track Firestop Seal: Pre-formed firestop device field-applied to head of top track that expands when exposed to heat or flames to provide a perimeter joint seal.
1. At Contractor's option provide preformed top track firestop seals instead of traditional perimeter joint seals.
2. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
3. Products:
   a. Hilti, Inc; Top Track Seal CFS TTS: www.us.hilti.com.
   b. Substitutions: See Section 01 6000 - Product Requirements.

D. Resilient Furring Channels: Galvanized sheet steel, single leg, asymmetrical channel, 1/2 inch deep with a 1-1/4 inch screw flange; complying with ASTM C645.
1. Exception: At ceilings provide double leg, symmetrical channels.
2. Protective Coating: ASTM A653/A653M, G40, hot-dip galvanized.
3. Minimum Metal Thickness: 0.0179 inch (25 gage).

E. Z-shaped Furring: Galvanized sheet steel z-shaped furring, 2 inches deep, unless otherwise indicated; complying with ASTM C645.
1. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized.
2. Minimum Metal Thickness: 0.0312 inch (20 gage).

2.04 FRAMING ACCESSORIES

A. Bridging and Bracing Members: Of same material as studs; thickness to suit purpose; complying with applicable requirements of ASTM C754.
   1. Steel, 0.0538-inch (1.37mm) minimum base-metal thickness, with a minimum 1/2-inch (13mm) wide flanges.
      a. Basis-of-Design Product: Subject to compliance with requirements, provide ClarkDietrich Systems Spazzer 9200 Bridge and Spacing Bar, or equivalent.

B. Backing Plates: 0.064 inch thick (16 gage), galvanized.

C. Wood Blocking: Refer to Section 06 1000 - Rough Carpentry.

D. Anchorage Devices: Powder actuated or Drilled expansion bolts.

E. Acoustic Sealant: As specified in Section 09 2900 - Gypsum Board.

F. Isolation Strip: Foam gasket, ASTM D3575, closed-cell vinyl foam strips, 1/8 inch thick, in width to suit steel stud size.
   1. Manufacturer:
      a. Williams; Everlastic EVA 200; www.williamsproducts.net.
      b. Substitutions: See Section 01 6000 - Product Requirements.

2.05 SHAFT WALL FRAMING MATERIALS

A. Non-Load-Bearing Steel Framing: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated and complying with requirements for fire-resistance-rated assembly indicated.
   1. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized.
   2. Minimum Metal Thickness: 0.0329 inch (20 gage).
   3. Profiles:
      a. Studs: Manufacturer's standard C-H or C-T profile.
         1) Depth: As indicated.
      b. Runners: Manufacturer's standard J-profile track; matching studs in depth.
      c. Slotted Deflection Track: As specified in "Framing Materials" above.
   4. Fasteners and Associated Materials: As specified in "Framing Accessories" above.

2.06 SUSPENSION SYSTEMS

A. Carrying Channels: ASTM C955; cold-rolled galvanized steel sheet U-channel.
   1. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized.
   2. Minimum Metal Thickness: 0.064 inch (16 gage).
   3. Depth: 2 inches unless otherwise indicated.

B. Furring Channels:
   1. Hat-Shaped, Rigid Furring Channels: As specified in "Framing Materials" above.
   2. Resilient Furring Channels: As specified in "Framing Materials" above.

C. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch (16 gage) diameter or double strand of 0.048-inch (18 gage) diameter wire.

D. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (8 gage) diameter.

E. Hanger Attachments to Concrete:
   1. Expansion Anchors: Fastener systems with evaluations based on ICC-ES AC193.
   2. Adhesive Anchors: Fastener systems with evaluations based on ICC-ES AC308.
   3. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
   4. Material for Exterior Locations and Interior Wet/Humid Locations: Alloy Group 1 (A1) stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
   1. At Contractor's option provide grid suspension system instead of traditional carrying and furring channels.
   2. Not permitted for multi-layer gypsum board systems.

3. Manufacturers:
   a. Armstrong World Industries, Inc.; Drywall Grid Suspension System: www.armstrongceilings.com.
   b. CertainTeed/Saint-Gobain; Quickspan Locking Drywall Grid System: www.certainteed.com.
   c. Rockfon, Part of the Rockwool Group; Chicago Metallic Drywall Grid: www.rockfon.com.
   d. USG Corporation: Drywall Suspension System: www.usg.com
   e. Substitutions: See Section 01 6000 - Product Requirements

2.07 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.

3.02 INSTALLATION OF STUD FRAMING

A. Comply with requirements of ASTM C754.
B. Install framing, shaft wall framing, suspension systems, and related accessories and components in accordance with manufacturer's instructions.
C. Extend partition framing to structure where indicated and to 4 inches above ceiling in other locations unless otherwise indicated.
D. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling framing in accordance with details.
E. 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.
F. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
G. Align and secure top and bottom runners at 24 inches on center.
H. Fire-Resistance-Rated Partitions: Install framing, including shaft wall framing, to comply with fire-resistance-rated assembly indicated.
I. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
   1. At partitions indicated with an acoustic rating:
      a. Provide components and install as required to produce STC ratings indicated, based on published tests by manufacturer conducted in accordance with ASTM E90 with STC rating calculated in accordance with ASTM E413.
      b. Place two beads of acoustic sealant between runners and substrate, studs and adjacent construction.
J. Curved Partitions:
   1. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   2. Begin and end each arc with a stud, and space intermediate studs equally along arcs.
K. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.
L. Install studs vertically at 16 inches on center, unless otherwise indicated.
   1. Install studs so flanges within framing system point in same direction
M. Align stud web openings horizontally.
N. Secure studs to tracks using fastener method. Do not weld.
   1. Secure studs to top and bottom runner tracks at both inside and outside flanges.
O. Stud splicing is not permissible.
P. Fabricate corners using a minimum of three studs.

Q. Install double studs at wall openings, door and window jambs, not more than 2 inches from each side of openings.
R. Brace stud framing system rigid.
S. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.
T. Blocking/Backing: Use metal backing plate, wood blocking, or supplementary framing secured to studs. Provide blocking/backing for support of equipment services, plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, and similar construction.
U. Furring: Install at spacing and locations shown on drawings. Lap splices a minimum of 6 inches.
V. Do not bridge building control and expansion joints. Frame both sides of joints independently.
    1. Install Horzontal stiffeners in stud system, spaced (vertical distance) not more than 4'-6" o.c.
W. General requirements and locations of control joints in metal-framed gypsum board construction:
    1. General: Comply with requirements of ASTM C840, and as noted below:
        a. Control joints shall be constructed with manufactured control joint trim, or field fabricated from materials as specified.
        b. Control joints will be installed where a partition, wall, or ceiling traverses and construction joint (expansion, or building control element) in the base building structure.
        c. Control joints will be installed where a wall or partition extends in an uninterrupted straight plane exceeding 30 linear feet. Door and/or window frames that extend full height of partitions will be considered equivalent to control joint construction.
        d. Control joints in interior ceilings, bulkheads, fasciae and soffits will be installed so that linear dimensions between control joints do not exceed 30 linear feet and total area between control joints does not exceed 900 square feet. Control joints will be installed to isolate wings of “L”, “U: and “T” shaped ceiling and soffit areas.
        e. A control joint will be installed where ceiling, bulkhead, fascia and soffit framing members change direction.
        f. Provide appropriate backing material, fire-safing insulation, and sealant for control joints installed in acoustical or fire-rated construction, as required to maintain fire-rating and/or acoustical separation.
X. Where studs are installed directly against exterior masonry walls, install isolation strip between studs and exterior wall.

3.03 CEILING AND SOFFIT FRAMING

A. Comply with requirements of ASTM C754.
B. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.
C. Install furring independent of walls, columns, and above-ceiling work.
D. Securely anchor hangers to structural members or embed in structural slab. Space hangers as required to limit deflection to criteria indicated.
    1. Space hangers at maximum 48 inches on center.
    2. Do not attach hangers to the following:
        a. Metal deck or rolled-in hanger tabs of composite metal deck.
        b. Permanent metal forms.
        c. Ducts, pipes, or conduit.
    3. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    4. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

5. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
    a. Size supplemental suspension members and hangers to support ceiling loads within performance requirements.

E. Space main carrying channels at maximum 48 inch on center, and not more than 6 inches from wall surfaces. Lap splices securely.

F. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.

G. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.
    1. Space furring channels at maximum 24 inches on center.

H. Laterally brace suspension system.

I. Grid Suspension Systems:
    1. Attach perimeter wall angle where grid suspension systems meet vertical surfaces.
    2. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

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.

C. Maximum variation From Level: 1/8 inch in 10 feet.

END OF SECTION 09 2216

SECTION 09 2900 - GYPSUM BOARD

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Gypsum wallboard.
B. Shaft wall liner panels.
C. Tile backing board.
D. Finishing materials.
E. Trim accessories.
F. Acoustic insulation.

1.02 REFERENCE STANDARDS

A. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2023.
B. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 2023.
C. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
D. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).
E. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
F. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).
G. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2023.
H. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2022.
I. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
J. 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.
K. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
L. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2024.
M. ASTM C1325 - Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units; 2022, with Editorial Revision (2023).
N. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
O. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2023.
P. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
Q. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
R. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
S. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
T. ASTM E413 - Classification for Rating Sound Insulation; 2022.
U. GA-216 - Application and Finishing of Gypsum Panel Products; 2024.
V. GA-226 - Application of Gypsum Board to Form Curved Surfaces; 2025.

W. GA-600 - Fire Resistance and Sound Control Design Manual; 2024.
X. UL (FRD) - Fire Resistance Directory; Current Edition.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.
   1. Include locations of control joints. Coordination drawings for proposed control joint locations may be annotated copies of Construction Documents architectural floor plans, reflected ceiling plans, and interior elevations. Submit prior to commencement of framing installation. Coordinate with requirements specified in Section 09 2216.
C. Product Data: Provide data on gypsum wallboard, shaft wall liner panels, tile backing panels, finishing materials, trim accessories, acoustical accessories, and fasteners and adhesives.
D. Samples:
   1. Submit three samples of each board type, 4 inches square in size.
   2. Submit three samples of each type of special trim, 4 inches in length.
E. Manufacturer's Qualification Statement.
F. Installer's Qualification Statement.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least 5 years of documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

1.05 FIELD CONDITIONS

A. Ambient Condition (Environmental Limitations): Comply with ASTM C840 and GA-216 requirements or gypsum board manufacturer's written instructions, whichever are more stringent

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Provide completed assemblies complying with ASTM C840 and GA-216.
B. Fire-Rated Assemblies: For fire-resistance-rated assemblies that incorporate gypsum board, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 and as follows:
   1. Provide construction equivalent to one of the following:
      a. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).
      b. Gypsum Association File Numbers: Provide construction complying with requirements of GA-600 for the particular assembly.
C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
D. Shaft Walls: Provide completed assemblies with the following characteristics:
   1. Comply with requirements of Fire-Rated Assemblies.
   2. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
      a. Air Pressure Within Shaft: Sustained loads of 7.5 lbf/sq ft with maximum mid-span deflection of L/240; unless otherwise indicated.
      b. Acoustic Attenuation: STC of 40-44 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90; unless otherwise indicated.
E. Horizontal Deflection: For wall assemblies, limit maximum deflection of wall framing to L/240 at 5 psf .
   1. Exception: Limit deflection of walls to receive hard tile surfaces to L/360 at 5 psf.

2.02 GYPSUM WALLBOARD

A. Gypsum Wallboard: Paper-faced gypsum panels; ASTM C1396/C1396M.
   1. Thickness: 1/4 and 1/2 inch.
   2. Long Edges: Tapered with paper face wrapping edge.
   3. Short Edges: Square cut.
   4. Sized to minimize joints.
   5. Products:
      a. CertainTeed Corp.; Regular Gypsum Board: www.certainteed.com.
      b. Continental Building Products; Regular Drywall: www.continental-bp.com.
      c. Georgia-Pacific Gypsum; ToughRock Gypsum Board: www.gp.com.
      d. National Gypsum Company; Gold Bond Brand Gypsum Board: www.nationalgypsum.com.
      e. USG Corporation; Sheetrock Brand Gypsum Panels: www.usg.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.

B. Gypsum Wallboard - Type X: Paper-faced gypsum panels with fire-resistant core; ASTM C1396/C1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered with paper face wrapping edge.
   3. Short Edges: Square cut.
   4. Sized to minimize joints.
   5. Type: Fire resistance rated Type X, UL or WH listed.
   6. Products:
      a. CertainTeed Corp.; Type X Gypsum Board: www.certainteed.com.
      b. Continental Building Products; Firecheck Type X: www.continental-bp.com.
      c. Georgia-Pacific Gypsum; ToughRock Fireguard X: www.gp.com.
      d. National Gypsum Company; Gold Bond Brand Fire-Shield Gypsum Board: www.nationalgypsum.com.
      e. USG Corporation; Sheetrock Brand Firecode X Panels: www.usg.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.

C. Impact Resistant Gypsum Wallboard: Heavy paper-faced, mold and moisture resistant, gypsum panel with fire-resistant core; ASTM C1396/C1396M.
   1. Thickness:5/8 inch.
   2. Long Edges: Tapered with paper face wrapping edge.
   3. Short Edges: Square cut.
   4. Sized to minimize joints.
   5. Type: Fire resistance rated Type X, UL or WH listed.
   6. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   7. Surface Abrasion: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
   8. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
   9. Soft Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
   10. Hard Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
   11. Products:
      a. CertainTeed Corp.; Extreme Impact Resistant Gypsum Board: www.certainteed.com.
      b. Continental Building Products; Protecta HIR 300 Type X with Mold Defense: www.continental-bp.com.
      c. National Gypsum Company; Gold Bond Brand Hi-Impact XP Gypsum Board: www.nationalgypsum.com.
      d. USG Corporation; Sheetrock Brand Mold Tough VHI Firecode X Panels: www.usg.com.
      e. Substitutions: See Section 01 6000 - Product Requirements.

2.03 SHAFT WALL LINER PANELS

A. Gypsum Shaft Wall Liner Panels: Moisture resistant paper-faced gypsum liner panels with fire-resistant core; ASTM C1396/C1396M
   1. Thickness: 1 inch.
   2. Width: 24 inches.
   3. Long Edges: Double beveled with paper face wrapping edge.
   4. Short Edges: Square cut.
   5. Sized to minimize joints.
   6. Type: Fire resistance rated Type X, UL or WH listed.
   7. Products:
      a. CertainTeed Corp.; M2Tech Shaftliner Type X: www.certainteed.com.
      b. Continental Building Products; Shaftliner Type X: www.continental-bp.com.
      c. Georgia-Pacific Gypsum; ToughRock Shaftliner: www.gp.com.
      d. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner: www.nationalgypsum.com.
      e. USG Corporation; Sheetrock Brand Gypsum Liner Panels: www.usg.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.

2.04 TILE BACKING BOARDS

A. Cementitious Backer Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
   1. Thickness: 5/8 inch.
   2. Flame Spread/Smoke Developed: 0/0 per ASTM E84.
   3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   4. Locations: Wet areas and elsewhere as indicated on Drawings; including, but not limited to, the following:
      a. Showers.
      b. Swimming pool areas.
   5. Products:
      a. National Gypsum Company; PermaBase Brand Cement Board: www.nationalgypsum.com.
      b. USG Corporation; Durock Brand Cement Board: www.usg.com.
      c. Substitutions: See Section 01 6000 - Product Requirements.

B. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
   1. Thickness: 5/8 inch.
   2. Type: Fire resistance rated Type X, UL or WH listed.
   3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
   4. Locations: Non-wet areas and elsewhere as indicated on Drawings; including, but not limited to, the following:
      a. Kitchens.
      b. Laundry areas.
      c. Locker rooms.
      d. Toilet rooms.
   5. Products:
      a. CertainTeed Corp.; GlasRoc Diamondback Tile Backer: www.certainteed.com.
      b. Georgia-Pacific Gypsum; DensShield Tile Backer: www.gp.com.
      c. National Gypsum Company; Gold Bond Brand eXP Tile Backer: www.nationalgypsum.com.
      d. USG Corporation; Durock Brand Glass-Mat Tile Backerboard: www.usg.com.
      e. Substitutions: See Section 01 6000 - Product Requirements.

2.05 FINISHING MATERIALS

A. Joint Materials: ASTM C475/C475Mand as recommended by gypsum board manufacturer for project conditions.

1. Paper Tape: 2 inch wide, creased paper tape for joints and corners.
   a. Exception: At tile backing board provide the following:
      1) Fiberglass Tape: 2 inch, coated glass fiber tape for joints and corners.
   b. Manufacturers: Provide products from one of the specified gypsum wallboard manufacturers.
2. Joint Compound: Drying and setting types, vinyl-based, ready-mixed or field-mixed.
   a. Each coat shall be compatible with previously applied coats.
   b. Manufacturers: Provide products from one of the specified gypsum wallboard manufacturers.

2.06 TRIM ACCESSORIES

A. Trim Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
   1. Types: As detailed or required for finished appearance. Including, but not limited to, the following:
      a. Corner beads.
      b. Control joints.
      c. LC or L bead at exposed edges.
   2. Products:
      a. ClarkDietrich Building Systems: www.clarkdietrich.com.
      b. Marino\WARE: www.marinoware.com.
      c. Telling Industries; www.buildstrong.com.
      d. Phillips Manufacturing Co: www.phillipsmfg.com.
      e. USG Corporation: www.usg.com.
      f. Substitutions: See Section 01 6000 - Product Requirements.

B. Special Trims: Extruded aluminum profiles; ASTM B221 6063 T5 alloy.
   1. Manufacturers:
      a. Fry Reglet Corp.; www.fryreglet.com.
      b. Gordon, Inc.; www.gordon-inc.com.
      c. Pittcon Industries; www.pittconindustries.com.
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. Shapes and Profiles: As indicated on Drawings, including, but not limited to, the following:
      a. Reveals: Equal to Fry Reglet Model DRM-625-625.
         1) Reveal Size: 5/8 inch wide by 5/8 inch deep
      b. F-Reveals: Equal to Fry Reglet Model DRMF-625-625.
         1) Reveal Size: 5/8 inch wide by 5/8 inch deep
      c. Wall End Caps: Equal to Fry Reglet DMEC Series.
         1) Size to match wall construction.
      d. Finish: Manufacturer's standard conversion coating or primed finish.

C. Partition Closures: Provide one of the following types.
   1. Aluminum Partition Closure: Aluminum spring loaded partition closure assembly with acoustical insulation.
      a. Extruded aluminum; ASTM B221 6063 T5 alloy
      b. Provide all auxiliary materials and hardware for a complete installation.
      c. Minimum STC rating of 38.
      d. Finish: Manufacturer's standard powder coating; custom color to match Architect's sample.
         1) Color: To match adjacent glazing framing unless otherwise indicated.
      e. Size closure to fit tightly in vertical juncture between end of partition and windows, glazing, and similar construction.
      f. Products:
         1) Gordon, Inc.; MullionMate Series: www.gordon-inc.com.
         2) Substitutions: See Section 01 6000 - Product Requirements.
   2. Foam Partition Closure: Silicone coated foam closures; compression fitted.
      a. Foam: Manufacturer's standard open-cell, fire-resistant foam core.
         1) Fire-resistance: Class A per ASTM E90.
      b. Finish Coating: Silicone; smooth finish.

1) Provide finish on exposed sides, and sides compressed against glazing.
2) Silicone Coating Color: Custom color to match Architect's sample.
(a) Color: To match adjacent glazing framing unless otherwise indicated.

c. Minimum STC rating of 53.
d. Depth of Seal: 2 inches, minimum.
e. Size closure to fit tightly in vertical juncture between end of partition and windows, glazing, and similar construction.
f. Products:
1) Emseal Joint Systems, Ltd.; QuietJoint: www.emseal.com.
2) Substitutions: See Section 01 6000 - Product Requirements.

3. Partition Closures: .
a. Sound Barrier Mullion Trip Cap
1) Products: MULL-it-OVER Products Mullion Trim Cap
2) Substitutions: See Section01 6000-Product Requirements.
b. Profile: 55 Classic Mullion Trim Cap
c. Aluminum Extrusion:
1) Thickness: 1/8 inch.
d. Sound Absorbing Foam:
1) Resistant to smoke, flame, and microbial growth.
2) Fire Rating: ASTM E84 Class 1.
3) Fungi Resistance: Zero rating per ASTM G21.
e. Compressible Foam: Between edge of extrusion and interior face of curtain wall glass.
1) Thickness: as required to accommodate mullion deflection.
2) Color: Light gray.
f. Fasteners:
1) Self Tapping or appropriate threaded fastener.
2) Compatible with all materials fasteners will contact with and not causing galvanic corrosion.
g. Snap Cover: Snap-on fastener cover
h. Acoustical Sound Sealant: Acrylic latex based.
i. Accessories: Provide necessary and related parts and tools to complete installation.
j. Fabrication: Extrusions and generic profiles to be shipped in custom lengths as required to meet project requirements or shipped in standard incremental foot lengths and cut to exact length on jobsite.
k. Finishes: Exposed surfaces of exposed aluminum extrusion:
l. Aluminum: Architect to select from manufacturer's custom color offering to match adjacent storefront finish.

2.07 ACOUSTICAL ACCESSORIES

A. Acoustic Insulation: Provide one of the following types:
1. Mineral Fiber/Rock Wool Batts: ASTM C665; preformed mineral fiber, friction fit type, unfaced.
a. Thickness: 3 inches, unless otherwise indicated.
b. Density: 2.5 pcf.
c. Flame Spread/Smoke Developed: 0/0 per ASTM E84.
d. Products:
1) JohnsManville; Mineral Wool Sound Attenuation Fire Batts (SAFB): www.jm.com.
2) Owens Corning; Thermafiber SAFB (Sound Attenuation Fire Batts): www.owenscorning.com.
3) Rockwool; Safe’n’Sound: www.rockwool.com.
4) Substitutions: See Section 01 6000 - Product Requirements.
2. Fiberglass Batts: ASTM C665; preformed glass fiber, friction fit type, unfaced.
a. Thickness: 3-1/2 inches, unless otherwise indicated.
b. Products:

1) CertainTeed Corporation/Saint-Gobain; NoiseReducer Sound Attenuation Batts: www.certainteed.com.
2) Johns Manville; Formaldehyde-Free Fiberglass Insulation: www.jm.com.
3) Knauf Insulation; EcoBatt Insulation with ECOSE Technology: www.knaufinsulation.com.
4) Owens Corning Corporation; EcoTouch Sound Attenuation Batts: www.owenscorning.com.
5) Substitutions: See Section 01 6000 - Product Requirements.

B. Acoustical Sealant: Nonsag, paintable, nonstaining latex sealant complying with ASTM C834. Reduces airborne sound transmission through perimeter joints and openings in wall assemblies.
1. Products:
a. Franklin International Inc; Titebond GreenChoice Professional Acoustical Smoke & Sound Sealant: www.titebond.com.
b. PPG Architectural Coatings; Liquid Nails AS-825 Acoustical Sound Sealant: www.liquidnails.com.
c. Pecora Corporation; AC-20 FTR: www.pecora.com.
d. Pecora Corporation; AIS-919: www.pecora.com.
e. United States Gypsum Co.; USG Sheetrock Brand Firecode Smoke-Sound Sealant: www.usg.com.
f. United States Gypsum Co.; USG Sheetrock Brand Acoustical Sealant: www.usg.com.
g. Substitutions: See Section 01 6000 - Product Requirements.

2.08 FASTENERS AND ADHESIVES

A. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inch in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion resistant.
B. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion resistant.
C. Screws for Fastening of Cementitious Backer Board Products to Steel Studs: Use screws of type and size recommended by panel manufacturer
D. Anchorage to Other Substrates: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.
E. Laminating Adhesive: For directly adhering gypsum-base, face-layer panels to backing-layer panels in multi-layer construction. Provide one of the following types:
1. Joint Compound: As recommended by gypsum board manufacturer.
2. Adhesives:
a. Franklin International, Inc; Titebond GREENchoice Professional Drywall Adhesive; www.titebond.com.
b. PPG Architectural Coatings; Liquid Nails DWP-24 Drywall Construction Adhesive: www.liquidnails.com.
c. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.
B. Control Joint Layout: Prior to commencement of framing and gypsum board installation, submit coordination drawings indicating proposed control joint locations in metal-framed gypsum board-sheathed partitions, walls, ceilings, bulkheads, fasciae, and soffits, for review and acceptance of Architect. Coordinate with requirements of Section 09 2216.

3.02 GENERAL INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

A. General: Apply acoustic accessories at all STC-Rated Assemblies and elsewhere as indicated on Drawings.
   1. Apply acoustic sealant at all smoke-tight assemblies.
   2. Fire-Rated Construction: Install acoustic accessories in strict compliance with requirements of assembly listing.

B. 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.

C. Acoustic Sealant: Install in accordance with manufacturer's instructions.
   1. Comply with ASTM C919.
   2. Place continuous bead at perimeter of each layer of gypsum board.
   3. Seal around all penetrations by conduit, pipe, ducts, rough-in boxes, and similar items, except where firestopping is provided.

3.04 BOARD INSTALLATION

A. Install to minimize butt end joints, especially in highly visible locations.
   1. Use screws for attachment of gypsum board.
   2. Use screws for attachment of cementitious backing board.

B. Single-Layer Non-Rated: Install gypsum board parallel to framing, with long edges occurring over framing.
   1. Stagger joints on opposite sides of partitions.

C. Multi-Layer Non-Rated: Install first layer of gypsum board parallel to framing with long edges occurring over framing. Place second layer parallel to framing with long edges occurring over framing, and joints offset from joints of first layer.
   1. Offset face-layer joints at least one stud or furring member from base-layer joints.
   2. Stagger joints on opposite sides of partitions.
   3. Install additional layers beyond double layers similarly; maintain offset and staggered joints between layers.
   4. Apply laminating adhesive between layers of gypsum board for bonding of layers in addition to fasteners.

D. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.

E. Cementitious Backing Board: Install in accordance with ANSI A108.11 and manufacturer's instructions.

F. Curved Surfaces: Apply gypsum board to curved substrates in accordance with GA-226.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as follows:
   1. Not more than 30 feet apart on walls and ceilings, unless otherwise indicated.
   2. Submit control joint locations to Architect for approval prior to installation.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim (LC or L Beads): Install at locations where gypsum board abuts dissimilar materials and as indicated, using longest practical lengths.

D. Special Trim: Install at indicated locations, and as follows.
   1. Wall End Caps: Provide at all exposed ends of wall assemblies not covered in wallboard and at locations of partition closures.
   2. Use longest practical lengths.

E. Partition Closures: Locate at vertical junctures between end of wall assemblies and windows, glazing, and similar construction, unless otherwise indicated.
   1. Notch around horizontal mullions, sills, or other obstructions leaving appropriate gap for differential movement between the sound barrier wall end cap and the obstruction.
   2. Apply continuous bead of acoustical sealant to the unexposed side of extruded aluminum surface that will be in contact with the wall edge.

3. Place sound barrier partition closure on the vertical surface of the wall partition and loosely install fasteners in the top and bottom slotted holes of the wall end cap.
4. Plumb the partition closure leaving recommended gap spacing between the interior glass surface and the wall end cap. Foam gasket to be in contact with glass.
5. Tighten top and bottom fasteners to secure partition closure.
6. Install additional fasteners at 12 inches on center, minimum.
7. Install snap cover to conceal fasteners.
8. Apply color matched sealant at joints of dissimilar materials.

3.06 JOINT TREATMENT

A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying or setting type joint compound and finish with drying type joint compound.

B. Tile Backing Panels: Use fiberglass joint tape, embed and finish with tile setting material.
   1. Refer to Section 09 3000 - Hard Tiling for tile setting materials.

C. Glass Mat Faced Gypsum Board other than Tile Backing Panels: Use fiberglass joint tape, embed and finish with setting type joint compound.

D. 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.
   2. Level 2: In utility areas, behind cabinetry, and in similar locations that shall not be painted or finished, and at tile backing board to receive tile finish.
   3. Level 1: Wall areas above finished ceilings, whether or not accessible in the completed construction.
      a. Exception: Fire-Rated Construction shall comply with requirements of assembly listing.

E. 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. Taping, filling and sanding is not required at base layers of multi-layer applications.

3.07 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 2900

SECTION 09 3000 - HARD TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hard tile.
B. Hard tile trim units.
C. Solid surfacing thresholds.
D. Tile setting materials, grout, sealants, and accessories.
E. Metal trim.
F. Waterproofing, Uncoupling, and Crack Isolation Membranes.

1.02 REFERENCE STANDARDS

A. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 2021.
B. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar; 2023.
C. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2023.
D. ANSI A118.11 - American National Standard Specifications for EGP (Exterior Glue Plywood) Modified Dry-Set Mortar; 2017 (Reaffirmed 2022).
E. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2014 (Reaffirmed 2024).
F. ANSI A118.15 - American National Standard Specifications for Improved Modified Dry-Set Cement Mortar; 2023.
G. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.
H. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
I. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
J. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2025.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
D. Samples:
    1. Full-size units of each type of tile and each color and finish.
    2. Full-size units of each type of trim, threshold and accessory for each color and finish.
        a. Trim and Threshold Samples: 4 inches long, minimum.
E. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 6000 - Product Requirements, for additional provisions.
    2. Extra Tile: 2 percent of each size, color, and surface finish combination, but not less than one box of each type.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

B. Installer Qualifications: Company specializing in performing tile installation, with minimum of five years of documented experience.

C. Source Limitations for Setting Materials and Accessories: Obtain product of a uniform quality for each application condition from a single manufacturer:

D. Preinstallation Conference: Conduct conference at the Project Site.

1. Convene one week prior to commencing work of this section.
2. Require attendance of installation material manufacturer, tile supplier, tile installer, and intallers of related work. Review installation procedures and coordination required with related work.
3. Meeting agenda includes, but is not limited to:
   a. Surface preparation.
   b. Tile and installation material compatibility.
   c. Manufacturer and installer warranty duration and scope coverd by warranty.
   d. Edge protection, transition, and pre-fabricated movement joint profiles.
   e. Waterproofing techniques.
   f. Crack isolation techniques.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to project site in manufacturer's original, unopened containers with labels intact. Inspect materials and notify manufacturer of any discrepancies.

B. Storage: Store materials as directed by manufacturer's written instructions.

1.07 FIELD CONDITIONS

A. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Floor Tile: Floor tile shall comply with the following:

1. Dynamic Coefficient of Friction (DCOF): 0.42 or greater when tested in accordance with DCOF AcuTest per ANSI A137.1.

2.02 HARD TILE

A. CT-1 Wall Tile: ANSI A137.1 standard grade.

1. Size:
   a. 12 by 12 inch, nominal.
   b. 12 by 24 inch, nominal
2. Thickness: 5/16 inch, nominal.
3. Surface Finish: Matte.
4. Color(s): _____
   a. CT1A Matte Designer White 0061.
   b. CT1B Matte Passion 0021.
5. Joint Size: 1/16 inch.
6. Products:
   a. American Olean; Color Story Floor: https://www.americanolean.com/.
   b. Substitutions: Not permitted.
   c. Manufacturer's Representative: Kathleen Black, kathleen.black@virginatile.com, 248.467.4362.

B. CT2 Floor Tile: ANSI A137.1 standard grade.

1. Size: 12 by 24 inch, nominal.
2. Thickness: 0.37 inch(9.5 mm), nominal.
3. Surface Finish: Unpolished (UPS).
4. Color(s): ARG17 Clean Slate.

5. Joint Size: 1/8 inch.
6. Base: Schluter Systems, DILEX-AHK. .
   a. Schluter-Systems: www.schluter.com.
   b. Substitutions: See Section01 6000-Product Requirements.
7. Products:
   a. Crossville; Argent 2.0: www.crossville.com.
   b. Substitutions: Not permitted.
   c. Manufacturer's Representative: Kathleen Black, kathleen.black@virginatile.com, 248.467.4362.

2.03 TILE TRIM UNITS

A. Trim Units: For tile with coordinating trim units, provide bullnoses, cove bases, and other shapes as required for a complete installation.
   1. Shapes: As selected by Architect from manufacturer's standard shapes; coordinate with adjacent flat tile sizes and jointing.
   2. Sizes: As selected by Architect from manufacturer's standard sizes; coordinate with adjacent flat tile sizes and jointing.
   3. Manufacturers: Same as adjacent flat tile, unless otherwsie indicated.

2.04 THRESHOLDS

A. Thresholds - General:
   1. Beveled Edges:
      a. Maximum Height: 1/2 inch.
      b. Bevel Slope: 1:2 slope.
      c. Align lower bevel edge with adjacent floor finish.
      d. Finish bevels to match threshold face.

B. THR-1Solid Surfacing Thresholds: Plastic resin casting complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler or unfilled, and pigments; homogenous, non-porous; no surface coating; color and pattern consistent throughout thickness.
   1. Size: 4 inches wide by full width of opening; 1/2 inch thick; beveled long edge, both sides.
   2. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
   3. Products:
      a. E. I. DuPont De Nemours and Co.; Corian Solid Surface: www.corian.com.
      b. Substitutions: Not permitted
   4. Color: Carbon Concrete

C. Applications:
   1. At doorways where tile terminates.

D. Latex-Portland Cement Thin-Set Mortar Bond Coat: ANSI A118.4, ANSI A118.11 andANSI A118.15 .
   1. Products:
      a. Bostik, Inc; Bostik PM: www.bostik.com.
      b. Custom Building Products; VersaBond Flex Professional Thin-Set Mortar: www.custombuildingproducts.com.
      c. H.B. Fuller Construction Products, Inc; Sturdi Flex Thin Set Mortar: www.tecspecialty.com/#sle.
      d. LATICRETE International, Inc; 253 Gold: www.laticrete.com.
      e. MAPEI Corp.; Porcelain Tile Mortar: www.mapei.com.
      f. Schluter Systems L.P.; All Set Thinset Morter; www.schluter.com
      g. Substitutions: See Section 01 6000 - Product Requirements.

E. Large Format Tile Latex-Portland Cement Medium-Bed Mortar Bond Coat: ANSI A118.4, ANSI A118.11 and ANSI A118.15 .
   1. Products:
      a. Bostik, Inc; Big Tile & Stone: www.bostik.com.
      b. Custom Building Products; Natural Stone & Large Tile Premium Mortar: www.custombuildingproducts.com.

c. LATICRETE International, Inc; 4-XLT: www.laticrete.com.
d. MAPEI Corp.; Large Tile & Stone Mortar: www.mapei.com.
e. Schluter Systems L.P.; All Set thinset mortar; www.schluter.com.
f. H.B. Fuller Construction Products Inc; Ultimate Large Tile Mortar or Permalastic LHT: www.tecspecialty.com.
g. Substitutions: See Section 01 6000 - Product Requirements.

F. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
1. Color(s):
a. CT1 Grout: Mapei, Warm Grey 5093
b. CT2 Grout: Mapei, Iron 5107
2. Products:
a. Bostik, Inc; EzPoxy EzClean: www.bostik.com.
b. Custom Building Products; CEG-Lite 100% Solids Commercial Epoxy Grout : www.custombuildingproducts.com.
c. H.B. Fuller Construction Products, Inc; TEC AccuColor EFX Epoxy Grout and Mortar : www.tecspecialty.com/#sle.
d. LATICRETE International, Inc; SPECTRALOCK Pro Premium: www.laticrete.com.
e. MAPEI Corp.; Kerapoxy or Kerapoxy CQ: www.mapei.com
f. Substitutions: See Section 01 6000 - Product Requirements.
1) Substitutions will only be accepted for manufacturers for epoxy grout. Product substitutions for other than epoxy grouts will not be accepted.

2.05 METAL TRIM

A. Metal Trim: Provide metal profiles in heights to match tile and setting-bed thicknesses, designed specifically for hard tile applications.
1. Profiles:
a. Angle or L-shaped.
b. Other shapes as indicated on Drawings.
2. Material: Brushed stainless steel.
3. Applications and Locations:
a. Open edges of wall tile.
b. Open edges of floor tile.
c. Outside wall corners.
d. Transitions between hard tile and other floor finishes.
e. Tile perimeters not against a wall or other solid vertical surface.
f. Other areas as indicated on Drawings.
4. Manufacturers:
a. Schluter-Systems: www.schluter.com.
b. Substitutions: See Section 01 6000 - Product Requirements.

2.06 WATERPROOFING AND CRACK ISOLATION MEMBRANE

A. Waterproofing and Crack Isolation Membrane: Elastomeric liquid applied membrane complying with ANSI A118.10 and ANSI A118.12.
1. Applications: Use at the following locations:
a. All floor and traffic areas.
b. Shower walls and floors.
c. Shower pans and walls.
d. Other areas as indicated.
2. Thickness: As recommended by membrane manufacturer.
3. Crack Resistance: No failure at 1/8 inch gap, minimum.
4. Membrane system may or may not include fabric reinforcing.
5. Products:
a. Without Fabric Reinforcing:
1) Custom Building Products; RedGard: www.custombuildingproducts.com.
2) LATICRETE International, Inc; Hydro Ban: www.laticrete.com.
3) LATICRETE International, Inc; Hydro Barrier: www.laticrete.com.

4) MAPEI Corp.; Mapelastic AquaDefense: www.mapei.com.
5) Substitutions: See Section 01 6000 - Product Requirements.

b. With Fabric Reinforcing:
1) Bostik, Inc; GoldPlus: www.bostik.com.
2) Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane: www.custombuildingproducts.com.
3) MAPEI Corp.; Mapelastic AquaDefense: www.mapei.com.
4) TEC, H.B. Fuller Construction Products Inc; HydraFlex: www.tecspecialty.com.
5) Substitutions: See Section 01 6000 - Product Requirements.

2.07 WATERPROOFING - SHEET APPLIED MEMBRANE

A. Waterproofing Membrane: Sheet Applied membrane complying with ANSI A118.10 andANSI A118.12 .
1. Schluter Systems; L.P. KERDI / KERDI DS Membrane: www.schluter.com.

2.08 UNCOUPLING MEMBRANE

A. Waterproofing and Uncoupling Membrane: Elastomeric liquid membrane complying with ANSI A118.10 and as defined in the Tile Council on North America (TCNA) Handbook.
1. Schluter Systems; L.P. DITRA / DITRA XL Membrane: www.schluter.com.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
1. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.
2. Verify that substrates comply with tolerances of TCNA (HB).

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
1. Verify that substrates comply with tolerances of TCNA (HB).

3.02 PREPARATION

A. Protect surrounding work from damage.
B. Vacuum clean surfaces and damp clean.

3.03 INSTALLATION - GENERAL

A. Install tile and thresholds and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.13, manufacturer's instructions, and TCNA (HB) recommendations.
B. Install waterproofing and crack isolation membrane according to manufacturer's instructions and TCNA (HB) recommendations.
1. Applications: Use at the following locations:
a. All floor and traffic areas.
b. Shower walls and floors.
c. Other areas as indicated.

C. Bond Coats:
1. Use latex-portland cement thin-set mortar, unless otherwise indicated.
a. Exceptions:
1) For tiles that have at least one side greater than 15 inches long, use large format tile latex-portland cement medium-bed mortar.
2) For large areas of glass tile, other than accents and bands, use glass tile latex-portland cement thin-set mortar.
b. Bond Coat Color: White or gray.
1) Exception: White at glass tiles.

D. Grout:
1. Use epoxy grout.

E. Install tile prior to installation of equipment, cabinets, and other recessed and surface mounted items.
F. Completely cover substrates with tile, including those which will be under and behind surface mounted items in finished construction.
G. Lay tile from center lines outward unless otherwise indicated.
H. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
I. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly.
J. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
K. Form internal angles square and external angles square, with metal trim, or bullnose trim pieces as indicated.
L. Install accessories rigidly in place in accordance with manufacturer's instructions..
M. Install metal trim in accordance with manufacturer's instructions.
N. Sound tile after setting. Replace hollow sounding units.
O. Keep control and expansion joints free of mortar, grout, and adhesive.
P. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
Q. Grout tile joints unless otherwise indicated.
R. Joint Sealant:
    1. Use joint sealant at the following locations instead of grout.
        a. Tile changes in plane.
        b. Tile-to-tile control joints .
        c. Junctions of tile and dissimilar materials
        d. And elsewhere as required by TCNA (HB), EJ171 movement joint guidelines.
    2. Install joint sealant with bond breaker tape or backer rod as appropriate to prevent three-sided bonding.
S. Grout Sealers:
    1. Seal the following:
        a. High performance grout joints only as recommended by grout manufacturer.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

A. Over concrete substrates, install in accordance with TCNA (HB) Method F122 or F122A, as appropriate to substrate conditions.
    1. Provide waterproofing and crack isolation membrane.

3.05 INSTALLATION - WALL TILE

A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244C .
    1. Provide waterproofing and crack isolation membrane in wet areas and elsewhere as indicated.
B. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.
    1. Provide waterproofing and crack isolation membrane where indicated.
C. Over concrete and masonry install in accordance with TCNA (HB) Method W202I.
    1. Provide waterproofing and crack isolation membrane in wet areas and elsewhere as indicated.

3.06 CLEANING

A. Clean tile and grout surfaces.

3.07 PROTECTION

A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION 09 3000

SECTION 09 5100 - ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended acoustical ceilings including:
   1. Metal grid suspension systems.
   2. Acoustical insulation above ceiling.

1.02 REFERENCE STANDARDS

A. ASTM B164 - Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire; 2014.
B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.
C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019 (Reapproved 2025).
D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
E. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).
F. ASTM D610 - Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces; 2008 (Reapproved 2019).
G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
H. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2024a.
I. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.
J. CISCA (CSH) - Ceiling Systems Handbook.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.
C. Product Data: Provide data on suspension system components and acoustical panels.suspension system components and acoustical panels.
D. Samples:
   1. Acoustical Panels: Submit 3 samples, 6 by 6 inch in size, for each type and finish of acoustical panel.
   2. Metal Grid Suspension Systems: Submit 3 samples each, 12 inches long, for each type and finish of suspension system main runner, cross runner, perimeter molding, and fascia trim.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Acoustical Panels: Quantity equal to 2 percent of total installed, but not less than one box for each type and finish.

1.05 QUALITY ASSURANCE

A. Metal Grid Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.

B. Acoustical Panel Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.
C. Installer Qualifications: Company experienced in performing acoustical ceiling installations, with minimum of 5 years of documented experience.

1.06 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Warranties: Provide the following manufacturer warranties:
   1. Acoustic Panel Warranty: Against defects in materials and workmanship.
      a. Warranty Length:
         1) 30 years.
   2. Metal Grid Suspension Systems: Against defects in materials and workmanship.
      a. Warranty Length:
         1) 30 years.
   3. Sag Warranty: Acoustic panels shall not show visible sag.
      a. Warranty Length: 30 years.
   4. Mold and Mildew Warranty: Acoustic panels shall be free from mold and mildew growth.
      a. Warranty Length: 30 years.
   5. Rust Warranty: Metal grid suspension systems shall be free from the occurrence of 50 percent red rust per ASTM D610.
      a. Warranty Length: 30 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acoustic Panels: Provide either the specified product or a comparable product by one of the following:
   1. Armstrong World Industries, Inc: www.armstrongceilings.com.
   2. CertainTeed Corporation: www.certainteed.com.
   3. USG Corporation: www.usg.com.
   4. Substitutions: See Section 01 6000 - Product Requirements.
B. Suspension Systems and Fascia Trim: Provide either the specified product or a comparable product by one of the following:
   1. Armstrong World Industries, Inc: www.armstrong.com.
   2. CertainTeed Corporation: www.certainteed.com.
   3. Rockfon North America/Chicago Metallic: www.rockfon.com.
   4. USG Corporation: www.usg.com.
   5. Substitutions: See Section 01 6000 - Product Requirements.
C. Source Limitations: Obtain acoustic panels, suspension systems, and fascia trims from one manufacturer unless otherwise indicated or approved in writing by Architect.

2.02 ACOUSTICAL PANELS

A. Acoustical Panels - General: ASTM E1264, Class A.
B. ACT-1 Acoustical Panels: Painted mineral fiber, ASTM E1264 Type III, with the following characteristics:
   1. Size: 24 by 24 inches.
   2. Thickness: 3/4 inch.
   3. Composition: Wet felted.
   4. Light Reflectance: 0.90, determined in accordance with ASTM E1264.
   5. NRC: 0.75, determined in accordance with ASTM E1264.
   6. Ceiling Attenuation Class (CAC): 35, determined in accordance with ASTM E1264.
   7. Edge: Square.
   8. Surface Color: White.

9. Suspension System: Exposed grid Type SG-1.
10. Products:
    a. USG Interiors, LLC; Mars Panels, No. 86185: www.usg.com.

2.03 SUSPENSION SYSTEMS

A. Metal Grid Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, and perimeter moldings as required.

B. SG-1 Exposed Steel Suspension System: Formed galvanized steel, commercial quality cold rolled; intermediate-duty.
   1. Profile: Tee; 15/16 inch wide face.
   2. Construction: Double web.
   3. Finish: White painted.
   4. Products:
      a. USG Interiors, LLC; USG Donn Brand DX: www.usg.com.

2.04 ACCESSORIES

A. Provide all required accessories including perimeter moldings, splice plates, clips, and associated hardware, hangers, rivets, and fasteners.

B. Hanger Wire, Anchors, and Related Support Materials:
   1. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
   2. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
   3. Size attachment devices for five times the design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.
   4. Size hanger wire for three times hanger design load indicated in ASTM C635/C635M, Table 1, Direct Hung, but not less than 0.106-inch diameter wire; three times the design load shall be less than yield stress of wire.

C. Perimeter Moldings: Same metal and finish as grid.
   1. At Wall Perimeters: Provide L-shaped molding for mounting at same elevation as face of grid.
   2. Provide inside and outside prefabrcated corner mouldings.
   3. At Bullnose Corners: Provide radius corner moldings to match bullnose radius of adjacent walls.
   4. **Teg Tabs are not acceptable.**

D. Touch-up Paint: Type and color to match acoustical and grid units.

2.05 ACOUSTICAL ACCESSORIES

A. Acoustic Insulation: Provide one of the following types:
   1. Mineral Fiber/Rock Wool Batts: ASTM C665; preformed mineral fiber, friction fit type, unfaced.
      a. Thickness: 3 inches, unless otherwise indicated.
      b. Density: 2.5 pcf.
      c. Flame Spread/Smoke Developed: 0/0 per ASTM E84.
      d. Products:
         1) JohnsManville; Mineral Wool Sound Attenuation Fire Batts (SAFB): www.jm.com.
         2) Owens Corning; Thermafiber SAFB (Sound Attenuation Fire Batts): www.owenscorning.com.
         3) Rockwool; Safe'n'Sound: www.rockwool.com.
         4) Substitutions: See Section 01 6000 - Product Requirements.
   2. Fiberglass Batts: ASTM C665; preformed glass fiber, friction fit type, unfaced.
      a. Thickness: 3-1/2 inches, unless otherwise indicated.
      b. Products:
         1) CertainTeed Corporation/Saint-Gobain; NoiseReducer Sound Attenuation Batts: www.certainteed.com.

2) Johns Manville; Formaldehyde-Free Fiberglass Insulation: www.jm.com.
3) Knauf Insulation; EcoBatt Insulation with ECOSE Technology: www.knaufinsulation.com.
4) Owens Corning Corporation; EcoTouch Sound Attenuation Batts: www.owenscorning.com.
5) Substitutions: See Section 01 6000 - Product Requirements.

B. Acoustical Sealant: Nonsag, paintable, nonstaining latex sealant complying with ASTM C834; for use in conjunction with perimeter moldings of suspended ceiling systems.
1. Products:
a. Franklin International Inc; Titebond GreenChoice Professional Acoustical Smoke & Sound Sealant: www.titebond.com.
b. PPG Architectural Coatings; Liquid Nails AS-825 Acoustical Sound Sealant: www.liquidnails.com.
c. Pecora Corporation; AIS-919: www.pecora.com.
d. United States Gypsum Co.; USG Sheetrock Brand Acoustical Sealant: www.usg.com.
e. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

A. Install after major above-ceiling work is complete.
B. Coordinate the location of hangers with other work.

3.03 REMOVAL, SALVAGING, AND REINSTALLATION OF EXISTING SUSPENDED ACOUSTICAL CEILINGS

A. Remove, salvage and reinstall existing acoustical panels and suspension system as required to facilitate new construction.
1. Take care not to scratch, chip, gouge, dent or otherwise damage acoustical panel faces or edges.
2. Take care not to scratch, bend, dent, twist, rack or otherwise damage suspension grid members.
3. Safely store removed materials and protect from damage.
B. Modify existing grid system and acoustic panels to accommodate new work.
C. Reinstall according to requirements of this Section for new work.
D. Replace any damaged or missing grid with new.
1. Match existing grid system in size, color, texture, and material.
E. Replace any damaged or missing acoustical panels with new.
1. Match existing acoustical panels in size, color, texture, and material.

3.04 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, CISCA (CSH), and manufacturer's instructions and as supplemented in this section.
B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
C. Locate system on room axis according to reflected plan.
D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
1. Install moldings in bed of acoustical sealant.
2. Install moldings and grid in the same plane.
3. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends.

4. Use longest practical lengths.
5. Corners:
   a. At Bullnose Corners: Provide prefabricated radius corner moldings to match bullnose radius of walls.
   b. At Square Corners: Provide prefabricated corner moldings.
      1) At Other Angles Corners: Overlap perimeter moldings.
6. Do not use exposed fasteners, including pop rivets.

E. Fascia Trim: Install fascia trim of type indicated at perimeter and transition locations indicated according to manufacturer's written instructions.

F. Hang metal grid suspension systems independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

G. Connect hangers directly to structure, inserts, eye screws, or other connections that are secure and appropriate for substrate. Connections shall not deteriorate or corrode.

H. Fasten hangers to structural members, cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
1. Do not attach hangers to metal forms, steel deck tabs, or metal decking.

I. Support metal grid suspension systems with hangers not more than 48 inches o.c. along main grid members.
1. Support grid members directly from hangers unless otherwise indicated.
2. Provide hangers not more than 8 inches from ends of each member.

J. Install hangers plumb except where required to miss obstructions; brace splayed hangers as required to offset horizontal forces.

K. Install supplemental hanger supports to bridge large ducts and other wide obstacles that interfere with required hanger spacings or when steel framing is not located appropriately for required hanger spacings.

L. Size hangers and supplemental supports to support ceiling loads within performance limits established by referenced standards and this specification section.

M. Secure wire hangers to metal grid suspension systems and above supports with four tight turns, minimum.

N. Hangers shall not contact adjacent materials within the ceiling plenum.

O. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

P. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

Q. Do not eccentrically load system or induce rotation of runners.

R. Do not install dented, bent, or kinked metal grid suspension members.

3.05 INSTALLATION - ACOUSTICAL PANELS

A. Install acoustical panels in accordance with manufacturer's instructions and as supplemented in this section.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install units after above-ceiling work is complete.

E. Install acoustical panels level, in uniform plane, and free from twist, warp, and dents.

F. Cutting Acoustical Units:
1. Make field cut edges of same profile as factory edges.
2. Field paint exposed cut edges.
3. No shadow trims to be used.

G. Lay acoustical insulation for a distance of 48 inches either side of acoustical partitions, unless otherwise indicated.
H. Lay acoustical insulation continuously across top of acoustical panel ceiling system without gaps where indicated.

3.06 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION 09 5100

SECTION 09 6466 - WOOD ATHLETIC FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Floating Resilient Floor System

1.02 RELATED REQUIREMENTS

A. Section 09 0561 - Common Work Results for Flooring Preparation: Independent agency testing of concrete slabs.
B. Section 09 6566- Resilient Athletic Flooring.

1.03 DEFINITIONS

A. NFHS; National Federation of State High School Associations.

1.04 REFERENCE STANDARDS

A. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
B. ASTM D4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications; 2016.

1.05 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.

1.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for flooring, subflooring, resilient cushion, and vented resilient base.
C. Shop Drawings: Indicate floor joint pattern and termination details.
    1. Indicate provisions for expansion and contraction and wall base.
    2. Indicate size and type fasteners and anchors.
    3. Show resilient pad layout and spacing.
D. Samples: Submit 3 samples 12 by 12 inch in size illustrating floor construction, floor finish, color, and sheen.
    1. Include 3 samples of vented base, 6 inches long for each color selected.
E. Maintenance Data: Include maintenance procedures and recommended maintenance materials.
F. Manufacturer's Qualification Statement.
G. Installer's Qualification Statement.

1.07 QUALITY ASSURANCE

A. Perform work of this section in accordance with MFMA (SPEC).
B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section.
    1. Minimum 5 years of documented experience.
    2. Member mill of the Maple Flooring Manufacturers Association, Inc (MFMA).
C. Installer Qualifications: Company specializing in installing products specified in this section.
    1. Minimum 5 years of documented experience.
    2. MFMA accredited and approved by flooring manufacturer.
D. Provide flooring system components by single manufacturer.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and store off the floor in a well-ventilated, weather-tight space.

1.09 FIELD CONDITIONS

A. Do not install wood flooring until wet construction work is complete and permanent heat and air conditioning is installed and operating.

B. Maintain room temperature between 55 degrees F and 75 degrees F and relative humidity between 35 to 50 percent for a period of seven days prior to delivery of materials to installation space, during installation, and after installation.

PART 2 PRODUCS

2.01 MANUFACTURERS

A. Floating Resilient Floor System
   1. Basis-of-Design: Connor Sports Flooring, Inc.; NeoShok: www.connorsports.com. Provide either the named product or a comparable product by one of the following:
      a. Action Floor Systems, LLC; ProAction Thrust: www.actionfloors.com.
      b. Horner Sports Flooring; Safe 2: www.hornerflooring.com.
      c. Robbins Sports Surfaces; Bio-Cushion Classic: www.robbinsfloor.com.
      d. Substitutions: Section 01 6000 - Product Requirements.

2.02 COMPONENTS

A. Flooring: RSF1.
   1. Refer to Section 09 6566 Resilient Athletic Flooring.
B. Subflooring: Two layers of 15/32 inch thick plywood, APA rated, exposure 1, minimum span rating of 32/16.
C. Subflooring: Manufacturer's standard pre-engineered subfloor suitable for system indicated.
   1. Material: Manufacturer's standard two-layer plywood construction.
   2. Resilient Cushioning: Manufacturer's standard pads, continuous pad strips, or continuous pads. Factory-applied to bottom of subflooring unless otherwise recommended by manufacturer.
      a. Thickness: 1/2 inch.
      b. Spacing: As recommended by manufacturer.
D. Channels: Galvanized steel, manufacturer's standard size and shape for system indicated.
   1. Minimum Thickness: 0.060 inch (16 gage).
E. Resilient Cushioning: Manufacturer's standard two stage rubber pads, factory-applied to bottom side of subflooring.
   1. Thickness: 3/4 inch.
   2. Durometer: Shore D 70; ASTM D2240.
   3. Spacing: As recommended by manufacturer.
F. Vapor Retarder: Polyethylene sheet, 6 mil thick, ASTM D4397; 2 inch wide tape for sealing sheet seams.
   1. Products:
      a. Fortifiber Corporation; Moistop Ultra 6: www.fortifibeer.com.
      b. Raven Industries Inc.; VaporBlock VB6: www.ravenefd.com.
      c. Stego Industries, LLC; Stegocrawl Wrap 6-mil Vapor Retarder: www.stegoindustries.com.
      d. Substitutions: Section 01 6000 - Product Requirements.
G. Fasteners and Anchors: Manufacturer's standard type and size to suit application.

2.03 ACCESSORIES

A. Adhesives: Types recommended by flooring manufacturer.
B. Subfloor Filler: Trowelable leveling and patching compound; latex-modified, hydraulic-cement-based formulation.
   1. Products:
      a. Ardex Engineered Cements; Ardex Feather Finish: www.ardexamerica.com. .
      b. Custom Building Products; Skim Coat & Patch Cement Underlayment; www.custombuildingproducts.com.
      c. TEC, an H.B. Fuller Construction Products Brand; Feather Edge Skim Coat with Patch Additive: www.tecspecialty.com.
      d. Substitutions: Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting this work.
B. Verify that concrete subfloor surface is smooth and flat to plus or minus 1/8 inch in 10 feet.
C. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
   1. Test in accordance with Section 09 0561 - Common Work Results for Flooring Preparation.

3.02 PREPARATION

A. Prepare substrate to receive wood flooring in accordance with manufacturer's and MFMA instructions.
   1. Concrete: Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
B. Vacuum clean substrate.

3.03 INSTALLATION

A. General:
   1. Install wood gymnasium flooring systems in accordance with manufacturer's and MFMA instructions.
B. Place vapor retarder over concrete surface, overlap seams a minimum of 6 inches and seal with tape.
C. Resilient Underlayment:
   1. Install pre-engineered subfloor perpendicular or diagonal to direction of finished floor with staggered joints in brick pattern, resilient pad side down,
   2. Allow 1/4 inch between plywood subfloor edges unless otherwise recommended by flooring manufacturer.
   3. Secure pre-engineered subfloor panels to concrete subfloor with metal channels; attach channels to concrete as recommended by flooring manufacturer.
D. Double Layer Plywood Subfloor:
   1. Place first layer at 90 degree angle to direction of finished floor, resilient pad side down.
   2. Fasten second layer (without pads) at 45 degree angle to first layer.
   3. Allow 1/4 inch between plywood subfloor edges.
E. Install solid blocking at doorways, under locations of heavy equipment, and as shown on drawings, in accordance with flooring manufacturer's recommendations.
F. Door Thresholds: Refer to Section 08 7100 - Door Hardware.

3.04 CLEANING

A. Clean floor surfaces in accordance with floor finish manufacturer's instructions.
   1. Complete final cleaning of floor not more than 5 days prior to Substantial Completion.

3.05 PROTECTION

A. Prohibit traffic on finished floor for 72 hours after installation.
B. After cleaning, place protective coverings over finish floors; do not remove coverings until Date of Substantial Completion.

END OF SECTION 09 6466

SECTION 09 6500 - RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Resilient tile flooring.

1.02 REFERENCE STANDARDS

A. ASTM F1344 - Standard Specification for Rubber Floor Tile; 2021a.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
C. Shop Drawings: Indicate seaming plans and floor patterns.
D. Verification Samples:
   1. Resilient Tile Flooring: Submit 3 samples, full size, for each color and pattern specified.
E. Sustainable Design Submittal: Submit VOC content documentation for flooring and adhesives.
F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Flooring Materials: Quantity equal to 2 percent of total installed, but not less than one box or roll for each type and color.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum 5 years documented experience.
B. Installer Qualifications: Company specializing in installing specified flooring with minimum 5 years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
B. Store all materials off of the floor in an acclimatized, weather-tight space.
C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
D. Protect roll materials from damage by storing on end.
E. Do not double stack pallets.

1.06 FIELD CONDITIONS

A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 TILE FLOORING

A. RTF1Rubber Tile: Homogeneous, color and pattern throughout thickness.
   1. Products:
      a. Interface Nora; Norament 992 Grano: https://shop.interface.com/US/en-US/resilient/nora-rubber/.
      b. Substitutions: Not permitted.
      c. Manufacturer's Representative: Sofia Davila, 347.633.0577, SOFIA.DAVILA@INTERFACE.COM
   2. Minimum Requirements: Comply with ASTM F1344, of Class corresponding to type specified.
   3. Size: 39.45 by 39.45 inch nominal.
   4. Total Thickness: 3.5 mm
   5. Texture: Hammered.

6. Installation Pattern: Monolithic.
7. Colors: Black Pepper 5304.

2.02 ACCESSORIES

A. Subfloor Filler: Cement based rapid drying smoothing and finishing compound; type recommended by adhesive manufacturer. Moisture resistant, Low VOC.

B. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.

C. Floor Moldings, Stair Coverings, and Resilient Base: Refer to Section 09 6513 - {\t\#1000017}.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).

1. Test in accordance with Section 09 0561 - Common Work Results for Flooring Preparation.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Prohibit traffic until filler is fully cured.

C. Clean substrate.

D. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION - GENERAL

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Adhesive-Applied Installation:

1. Fully adhere resilient floor finishes to substrates using a full spread of adhesive completely covering substrate.
2. Spread only enough adhesive to permit installation of materials before initial set.
3. Fit joints and butt seams tightly.
4. Set flooring in place, press with heavy roller to attain full adhesion.

D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

E. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

F. Install flooring in recessed floor access covers, maintaining floor pattern.

G. At movable partitions, install flooring under partitions without interrupting floor pattern.

H. Coordinate with Section 09 6513 - {\t\#1000017} for installation of floor moldings, stair coverings, and resilient base.

3.04 INSTALLATION - TILE FLOORING

A. Mix tile from containers to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

B. Installed floor tile shall be without open cracks, bubbling, telegraphing of adhesive spreader marks, and other imperfections.

C. Install resilient tile in floor patterns indicated.

D. Where no patterns are indicated, lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.

3.05 CLEANING

A. Remove excess adhesive from floor surfaces without damage.

B. Clean in accordance with manufacturer's written instructions.

1. Seal resilient floor finishes only when recommended by resilient floor finish manufacturer.
2. Wax resilient floor finishes only when recommended by resilient floor finish manufacturer.
   a. Apply not less than two coats as recommended by manufacturer.
3. Do not seal or wax luxury vinyl tile.

C. Clean resilient flooring not more than 5 days prior to Substantial Completion in accordance with resilient flooring manufacturer's instructions

3.06 PROTECTION

A. Prohibit traffic on resilient flooring for 48 hours after installation.

B. After cleaning, place protective coverings over finish floors; do not remove coverings until Date of Substantial Completion.

END OF SECTION 09 6500

SECTION 09 6513 - RESILIENT BASES AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Resilient base.
B. Stair coverings.
C. Floor moldings.

1.02 REFERENCE STANDARDS

A. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021 (Reapproved 2025).
B. ASTM F2169 - Standard Specification for Resilient Stair Treads; 2015 (Reapproved 2020).

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
C. Shop Drawings: Indicate seaming plans and floor patterns.
D. Verification Samples:
   1. Resilient Base, Floor Moldings, and Stair Coverings: Submit 3 samples, 12 inches long illustrating color, pattern, and profile for each accessory specified.
E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Wall Base: Quantity equal to 2 percent of total installed, but not less than 8 linear feet of each type and color.
   3. Extra Stair Covering Materials: Quantity equal to 2 percent of total installed, but not less than 8 linear feet for each type and color.
   4. Extra Floor Moldings: Quantity equal to 2 percent of total installed, but not less than 8 linear feet of each type and color.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified resilient accessories with minimum 5 years documented experience.
B. Installer Qualifications: Company specializing in installing specified resilient accessories with minimum 5 years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
B. Store all materials off of the floor in an acclimatized, weather-tight space.
C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
D. Protect roll materials from damage by storing on end.
E. Do not double stack pallets.

1.06 FIELD CONDITIONS

A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 STAIR COVERING

A. STR1Stair Treads with Integral Risers: Rubber; full height of riser, full width and depth of tread in one piece; tapered thickness.
   1. Manufacturers: Provide products from one of the following:
      a. Interface Nora: https://shop.interface.com/US/en-US/resilient/nora-rubber/.
      b. Substitutions: Not permitted.

c. Manufacturer's Representative: Sofia Davila, 347-633-0577, sofia.davila@interface.com
2. Minimum Requirements: Comply with ASTM F2169, Type TS, rubber, vulcanized thermoset.
3. Nominal Thickness: 0.1875 inch.
4. Nosing: Square.
5. Striping: 2 inch wide contrasting color strips.
   a. Color: Black Smooth.
6. Tread Texture: Hammered.
7. Colors: Black Pepper 5304.

2.02 RESILIENT BASE

A. RB1Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove.
1. Manufacturers: Provide products from one of the following:
   a. Armstrong Flooring Inc.: www.armstrongflooring.com.
   b. Burke Flooring: www.burkeflooring.com.
   c. Johnsonite, a Tarkett Company: www.johnsonite.com.
   d. Roppe Corp: www.roppe.com.
   e. Substitutions: See Section 01 6000 - Product Requirements.
2. Height: 4 inch.
3. Thickness: 0.125 inch.
4. Finish: Satin.
5. Length: Roll.
6. Colors: Black.

2.03 FLOOR MOLDINGS

A. Floor Moldings: Resilient edge and transition strips for changes in flooring materials.
1. Manufacturers:
   a. Johnsonite, a Tarkett Company: www.johnsonite.com.
   b. Substitutions: See Section 01 6000 - Product Requirements.
2. Material: Rubber or vinyl as is standard with manufacturer.
3. Profiles: As standard with manufacturer and as appropriate for floor finishes, unless otherwise indicated
4. Provide floor moldings at the following locations unless otherwise indicated:
   a. Open perimeters of resilient flooring; reducer strips.
   b. Open perimeters of carpeting; edge guards.
   c. Changes in floor finishes from resilient flooring to carpeting; transition strips.
   d. Other areas as indicated or required for complete floor finish installations.
   e. Height changes due to various flooring thickness:
      1) RSF3 (10.5mm) to CONCS
      2) RSF3 (10.5mm) to RSF1 (6mm)
      3) RSF2 (10mm) to RSF1 (6mm)
      4) RSF2 (10mm) to RFT1 (3.5mm)
      5) RSF2 (10mm) to CONCS
      6) CPT1 (0.222 inches) to RSF2 (10mm)
      7) RFT1 (3.5mm) to CONCS
5. Colors: As selected by Architect.

2.04 ACCESSORIES

A. Primers and Adhesives: Waterproof; types recommended by accessories manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to stair covering manufacturer, free of cracks that might telegraph through stair coverings, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of stair coverings to substrate.

B. Verify that surfaces are flat, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of floor moldings to substrate.

C. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

3.02 PREPARATION

A. Clean substrates.

3.03 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's written instructions.

B. Adhesive-Applied Installation:

1. Fully adhere resilient base, stair coverings, and floor moldings, to substrates using a full spread of adhesive completely covering substrate.
2. Spread only enough adhesive to permit installation of materials before initial set.
3. Fit joints and butt seams tightly.

C. Install floor moldings at unprotected or exposed edges, where flooring terminates, and where indicated.

1. Resilient Strips: Attach to substrate using adhesive.

3.04 INSTALLATION - RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.

B. Install with minimal amount of joints; tops of adjacent pieces shall be aligned.

C. Miter internal corners. At external corners, 'V' cut back of base strip to 2/3 of its thickness and fold. At exposed ends, use premolded units.

D. Install base on solid backing. Bond tightly to wall and floor surfaces.

E. At masonry and other irregular substrates fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.

F. Scribe and fit to door frames and other interruptions.

3.05 INSTALLATION - STAIR COVERINGS

A. Install stair coverings in one piece for full width and depth of tread, where possible.

B. Adhere over entire surface. Fit accurately and securely.

C. Use filler as recommended by stair covering manufacturer to fill substrates that do not conform tightly to stair covering contours.

3.06 INSTALLATION - FLOOR MOLDINGS

A. Install floor moldings in one piece for full width of installation, where possible.

B. Where joints are unavoidable, fit tightly together and align adjacent molding profiles.

C. Adhere over entire surface. Fit accurately and securely.

3.07 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

3.08 PROTECTION

A. Prohibit traffic on resilient stair coverings and floor moldings for 48 hours after installation.

END OF SECTION 09 6513

SECTION 09 6566 - RESILIENT ATHLETIC FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Rubber sheet flooring, adhesively installed.

1.02 RELATED REQUIREMENTS

A. Section 03 3003 - Cast-In-Place Concrete Requiremenys for Floor Slabs - Methods and materials for moisture reducing admixtures in cast-in place concrete and related testing.
B. Section 09 0561 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.

1.03 REFERENCE STANDARDS

A. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
B. EN 14808 - Surfaces For Sports Areas - Determination of Shock Absorption; 2005.
C. EN 14809 - Surfaces For Sports Areas - Determination of Vertical Deformation; 2005.
D. EN 1516 - Surfaces For Sports Areas - Determination of Resistance to Indentation; 2005.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's printed data sheets for products specified.
C. Shop Drawings: Fabrication and installation details, and layout, colors, and widths of game lines and equipment locations.
D. Selection Samples: Manufacturer's color charts for flooring materials specified and game line paints, indicating full range of colors and textures available.
E. Verification Samples:
   1. Resilient Flooring: Submit 3 samples, 8 inch square, illustrating color and pattern for each resilient flooring product specified.
F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum 5 years documented experience.
B. Installer Qualifications: Company specializing in installing specified flooring with minimum 5 years documented experience and approved by flooring manufacturer.
C. Floor Slab Moisture Content: Manufacturer and Installer of Athletic Surfacing acknowledge that concrete slabs scheduled to receive Athletic Surfacing products are constructed with concrete mix designs containing water-vapor reducing admixtures. Manufacture and Installer of Athletic Surfacing agree to cooperate with manufacturer of water–vapor reducing admixtures including methods for testing slab moisture content, interpretation of moisture test results, and methods for slab preparation to receive Athletic Surfacing. Claims for additional compensation based on disagreements arising from interpretation of slab moisture testing will not result in additional costs to the Owner, or be acceptable cause for modification of warranty (guarantee) requirements included in this section or other sections of the contract documents.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in unopened containers clearly labeled with manufacturer's name and identification of contents.
B. Store materials in dry and clean location until needed for installation. During installation, handle in a manner that will prevent marring and soiling of finished surfaces.

1.07 FIELD CONDITIONS

A. Maintain temperature in spaces to receive adhesively installed resilient flooring within range of 70 to 95 degrees F for not less than 48 hours before the beginning of installation and for not less than 48 hours after installation has been completed. Subsequently, do not allow temperature in installed spaces to drop below 50 degrees F or to go above 100 degrees F.

PART 2 PRODUCTS

2.01 PREFORMED ATHLETIC FLOORING

A. RSF1 Resilient Ahtletic Flooring - Multipurpose
   1. Rubber Sheet Flooring: Multi-layer, dual-durometer, vulcanized sheet rubber flooring; smooth top wear layer with marbleization throughout the wear layer's entire depth.
      a. Products:
         1) Mondo USA; Advance, 2 Layer: www.mondoworldwide.com
         2) Substitutions: Not permitted.
         3) Manufacturer's Representative: Kevin Walsh, 847.887.9541, Kevin@kieferusa.com.
      b. Total System Thickness: 6mm
      c. Sheet Width: 6 feet, 1 inch
      d. Sheet Lengths: As necessary to minimize transverse seams.
      e. Wear Layer:
         1) Wear Layer Thickness: 2mm.
         2) Surface Finish: Smooth
         3) Color: L70 Light Grey.
      f. Performance Requirements:
         1) Durameter Hardness. Type A: When tested in accordance with ASTM D2240.
            (a) Top/Wear Layer: 78 mininum
            (b) Bottom Layer: 60 minimum

B. RSF2 Resilient Ahtletic Flooring - Multipurpose
   1. Rubber Sheet Flooring: Multi-layer, dual-durometer, vulcanized sheet rubber flooring; smooth top wear layer with marbleization throughout the wear layer's entire depth.
      a. Products:
         1) Mondo USA; Advance, 2 Layer: www.mondoworldwide.com
         2) Substitutions: Not permitted.
         3) Manufacturer's Representative: Kevin Walsh, 847.887.9541, Kevin@kieferusa.com.
      b. Total System Thickness: 8mm
      c. Sheet Width: 6 feet, 1 inch
      d. Sheet Lengths: As necessary to minimize transverse seams.
      e. Wear Layer:
         1) Wear Layer Thickness: 10mm.
         2) Surface Finish: Smooth
         3) RSF2A: L70 Light Grey.
         4) RSF2B: L06 Dark Grey.
      f. Performance Requirements:
         1) Durameter Hardness. Type A: When tested in accordance with ASTM D2240.
            (a) Top/Wear Layer: 78 mininum
            (b) Bottom Layer: 60 minimum

C. RSF3Resilient Athletic Flooring - Running Track:
   1. Rubber Sheet Flooring: Multi-layer, dual-durometer, vulcanized sheet rubber flooring; textured top wear layer with hexagonal backing layer.
      a. Products:
         1) Mondo USA; Super X 720: www.mondoworldwide.com.
         2) Substitutions: Not permitted.
         3) Manufacturer's Representative: Kevin Walsh, 847.887.9541, Kevin@kieferusa.com.

b. Total System Thickness: 10.5mm (13/32 inches).
c. Sheet Width: Minimum 48 inches.
d. Sheet Lengths: As necessary to minimize transverse seams.
e. Wear Layer:
    1) Surface Finish: Super X 720 Embossing
    2) Colors:
        (a) RSF3A: Dark Grey P06
        (b) RSF3B: Terracotta P121
        (c) RSF3C: Medium Grey P31
f. Game Lines: Manufacturer's standard pigmented polyurethane paint.
    1) Colors: Up to 1 colors.
        (a) White.
g. Performance Requirements:
    1) Durometer Hardness, Type A: When tested in accordance with ASTM D2240:
        (a) Top/Wear Layer: 55, minimum.
        (b) Bottom Layer: 35, minimum.

2.02 ACCESSORIES

A. Leveling Compound: Latex-modified cement formulation as recommended by flooring. manufacturer for substrate conditions.
B. Flooring Adhesive: Waterproof; types recommended by flooring manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates for conditions detrimental to installation of athletic flooring. Proceed with installation only after unsatisfactory conditions have been corrected.
B. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of athletic flooring to substrate.
C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
    1. Test in accordance with Section 09 0561 - Common Work Results for Flooring Preparation.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
B. Concrete: Use leveling compound as necessary to achieve substrate flatness of plus or minus 1/8 inch within 10 ft radius.
C. Remove coatings that are incompatible with flooring adhesives, using methods recommended by flooring manufacturer.
D. Broom clean areas to receive athletic flooring immediately before beginning installation.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.
B. Install in accordance with manufacturer's written instructions.
C. Rubber Sheet Flooring:
    1. Installed sheet flooring shall be without open cracks, raising and puckering at joints, bubbling, telegraphing, and other imperfections.
    2. Unless otherwise indicated lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
    3. Unroll flooring and allow to relax before beginning installation.

4. Mix adhesive thoroughly and apply to substrate with notched trowel. Roll flooring into fresh adhesive, overlapping end seams and double cutting, butting factory edges and compression fitting.
5. Roll entire flooring surface with steel roller to assure adhesion to substrate and eliminate air bubbles.
6. Immediately remove any adhesive from flooring surface, using chemical recommended by flooring manufacturer.
7. Fit joints and butt seams tightly.
8. Lay out game lines using tape and taping machine approved by flooring manufacturer. Apply game line paint with roller, and allow to dry before removing tape.
9. Apply transparent top coat over flooring if recommended by manufacturer, to achieve a uniform finished appearance.

3.04 CLEANING

A. Clean flooring using methods recommended by manufacturer.
   1. Complete final cleaning of floor not more than 5 days prior to Substantial Completion.

3.05 PROTECTION

A. Protect finished athletic flooring from construction traffic to ensure that it is without damage upon Date of Substantial Completion.
   1. After cleaning, place protective coverings over finished floors; do not remove coverings until Date of Substantial Completion.

END OF SECTION 09 6566

SECTION 09 6813 - TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Carpet tile, fully adhered.

1.02 REFERENCE STANDARDS

A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).
B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2025.
C. CRI 104 - Standard for Installation of Commercial Carpet; 2018.
D. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
C. Shop Drawings: Indicate layout of joints, direction of carpet pile, and location of edge moldings .
D. Verification Samples:
   1. Carpet Tile: Submit 3 samples, full size, for each color and pattern specified.
E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Carpet Tiles: Quantity equal to 2 percent of total installed, but not less than one box for each type and color.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum 5 years documented experience.
B. Installer Qualifications: Company specializing in installing carpet tile with minimum 5 years documented experience.

1.05 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

1.06 EXTRA MATERIALS

A. Deliver stock of maintenance materials to Owner. Furnish maintenance materials from same manufactured lot as materials installed and enclosed in protective packaging with appropriate identifying labels.
   1. Carpet Tile Flooring: Furnish not less than one box for each 50 boxes or fraction thereof, for each type, color, pattern, and size installed.

PART 2 PRODUCTS

2.01 MATERIALS

A. CPT1Tile Carpeting:
   1. Product:
      a. Tarkett; Abrasive Action II #02578: https://commercial.tarkett.com/.
      b. Substitutions: Not permitted.
      c. Manufacturer's Representative: Paul Brown, 810.908.4344, Paul.Brown@tarkett.com.
   2. Construction: Accuweave Patterned Loop.
   3. Tile Size: 24 x 24 inch, nominal.
   4. Color: Solar Flare 19109

5. Installation Pattern: Monolithic.
6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
8. Fiber Content: TDX Nylon.
9. Dye Method: 100 percent solution dyed.
10. Density Factor: 7,513 oz/cu yd..
11. Secondary Backing Material: Ethos Modular with Omnicoat Technology.

2.02 ACCESSORIES

A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
B. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.
C. Floor Moldings, Stair Coverings, and Resilient Base: Refer to Section 09 6513 - Resilient Bases and Accessories.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.
C. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
    1. Test in accordance with Section 09 0561 - Common Work Results for Flooring Preparation.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.
C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
D. Vacuum clean substrate.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.
B. Install carpet tile in accordance with manufacturer's instructions and CRI 104 (Commercial).
C. Blend carpet from different cartons to ensure minimal variation in color match.
D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
E. Install carpet tile in floor patterns indicated.
F. Locate change of color or pattern between rooms under door centerline.
G. Trim carpet tile neatly at walls and around interruptions.
H. Coordinate with Section 09 6513 - Resilient Bases and Accessories for installation of floor moldings, stair coverings, and resilient base.

3.04 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
B. Clean and vacuum carpet surfaces.
C. Complete final cleaning of floor not more than 5 days prior to Substantial Completion.

3.05 PROTECTION

A. After cleaning, protect finish floors from damage until Date of Substantial Completion.

END OF SECTION 09 6813

SECTION 09 9123 - INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.
B. Field application of paints.
C. Specification for Canyon Tone for clear block sealer is in Specification 07 1900 Water Repellent Acrylic Penetrating Sealer.
D. Do Not Paint or Finish the Following Items:
   1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
   5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
   6. Marble, granite, slate, and other natural stones.
   7. Floors, unless specifically indicated.
   8. Brick, architectural concrete, cast stone, integrally colored plaster, and stucco.
   9. Glass.
   10. Acoustical materials, unless specifically indicated.
   11. Concealed pipes, ducts, and conduits.

1.02 DEFINITIONS

A. Comply with ASTM D16 for interpretation of terms used in this section.

1.03 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2024.
C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020.
D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.
E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
F. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
G. SSPC-SP 13 - Surface Preparation of Concrete; 2018.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide complete list of products to be used, with the following information for each:
   1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
   2. MPI product number (e.g., MPI #47).
   3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
   1. Where sheen is specified, submit samples in only that sheen.
   2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens not required.

D. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.06 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F above the dew point, or to damp or wet surfaces.

D. Minimum Application Temperatures for Paints: 50 degrees F for interiors unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.

B. Provide paints and finishes from the same manufacturer to the greatest extent possible.

1. If a single manufacturer cannot provide specified products; minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
2. Substitution of MPI-approved products by a different manufacturer is preferred over substitution of unapproved products by the same manufacturer.
3. Substitution of other products by the same manufacturer is preferred over substitution of products by a different manufacturer.
4. Substitution of a different paint system using MPI-approved products by the same manufacturer will be considered.

C. Paints:

1. Pittsburgh Paints: www.ppgpaints.com/#sle.
2. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
3. Benjamin Moore; www.benjaminmoore.com/#sle

D. Primer Sealers: Same manufacturer as top coats.

E. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PAINTS AND FINISHES - GENERAL

A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.

1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
2. 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.

3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
4. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
5. Supply each paint material in quantity required to complete entire project's work from a single production run.
6. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

B. Volatile Organic Compound (VOC) Content:
1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
   a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
   b. Architectural coatings VOC limits of the State in which the Project is located.
2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

D. Colors: To be selected from manufacturer's full range of available colors.
1. Selection to be made by Architect after award of contract.
2. Extend colors to surface edges; colors may change at any edge as directed by Architect.
3. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling under which they are mounted.
4. In utility areas, finish equipment, piping, conduit, and exposed duct work in colors according to the color coding scheme indicated.
5. During bidding, price accent walls as low-hide colors. Include pricing for additional prep and coats as required.

2.03 PAINT SYSTEMS - INTERIOR

A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, brick, wood, uncoated steel, shop primed steel, and galvanized steel.
1. Two top coats and one coat primer.
2. Top Coat(s): Interior Latex; MPI #44, 53, 54.
   a. Products:
      1) Benjamin Moore Super Hide Zero VOC Interior Latex Flat 355 (MPI #53).
      2) Benjamin Moore Super Hide Zero VOC Interior Latex Low Sheen 356 (MPI #44)
      3) Benjamin Moore Super Hide Zero VOC Interior Latex Semi-Gloss 358 (MPI # 53)
      4) Benjamin Moore Ultra Spec 500 Interior Latex, Flat T535 (MPI #53) (Dark Colors)
      5) Benjamin Moore Ultra Spec 500 Interior Latex, Low Sheen Eggshell T537 (MPI #44) (Dark Colors)
      6) Benjamin Moore Ultra Spec 500 Interior Latex, Semi-Glass T546 (MPI # 54) (Dark Colors)
      7) Pittsburgh Paints Speedhide Zero Interior Latex, 6-4110XI Series, Flat. (MPI #53)
      8) Pittsburgh Paints Speedhide Zero Interior Latex, 6-4310XI Series, Eggshell. (MPI #44)
      9) Pittsburgh Paints Speedhide Zero Interior Latex, 6-4510XI Series, Semi-Gloss. (MPI #54)
      10) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Flat B30W12651 (MPI #53).

11) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Semi-Gloss. (MPI #43)
12) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Eggshell. (MPI #52)

3. Top Coat Sheen:
   a. Flat: MPI gloss level 1; use this sheen for ceilings and other overhead surfaces.
   b. Eggshell: MPI gloss level 3; use this sheen at gypsum board, except at ceilings and wood.
   c. Satin: MPI gloss level 4; use this sheen for items subject to frequent touching by occupants, including door frames and railings.
   d. Semi-Gloss: MPI gloss level 5; use this sheen at masonry and metals .
4. Primer: As recommended by top coat manufacturer for specific substrate.

B. Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals:
1. Medium duty applications include doors, door frames, railings, handrails, guardrails, and balustrades.
2. Two top coats and one coat primer.
3. Top Coat(s): High Performance Architectural Interior Latex - Steel Doors and Door Frames; #141.
   a. Products:
      1) Benjamin Moore Pre-Catalyzed Waterborne Epoxy Semi-Glass, V341 (MPI #141)
      2) Pittsburgh Paints Pure Performance Interior Latex, 9-510XI Series, Semi-Gloss. (MPI #141)
      3) Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, K46W01151 Semi-Gloss. (MPI #141)
      4) Substitutions: See Section 01 6000 - Product Requirements
4. Top Coat(s): Interior Light Industrial Coating, Aluminum, Ferrous Metal Galvanized Steel except Steel Door and Frames Water Based; MPI #153.
   a. Products:
      1) Benjamin Moore Ultra Spec HP DTM Acrylic Semi-Glass HP29 (MPI #153)
      2) Pittsburgh Paints Pitt-Tech Plus WB DTM Industrial Enamel. 4216 HP Series, Semi-Gloss. (MPI #153)
      3) Sherwin-Williams Pro Industrial DTM Acrylic Semi-Gloss, B66W01150 Series. (MPI #153)
5. Top Coat Sheen:
   a. Semi-Gloss: MPI gloss level 5; use this sheen at all locations.

C. Paint I-OP-MD-WC - Medium Duty Vertical: Including gypsum board, concrete masonry units, and Structural Glazed Facing Tile.
1. Drawing Designation EP.
2. Two top coats and one coat primer.
3. Top Coat(s): High Performance Architectural Interior Latex; MP #141.
   a. Products:
      1) Benjamin Moore Pre-Catalyzed Waterborne Epoxy, Eggshell V342 (MPI #138)
      2) Benjamin Moore Pre-Catalyzed Waterborne Epoxy, Semi-Glass V341 (MPI #141)
      3) Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, Eg-Shel. (MPI #139)
      4) Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, Semi-Gloss. (MPI #141)

D. Paint I-OP-DF - Dry Fall: Metals; exposed structure and overhead-mounted services in utilitarian spaces, including shop primed steel deck, structural steel, metal fabrications, galvanized ducts, galvanized conduit, and galvanized piping.
1. Shop primer by others.
2. One top coat.
3. Top Coat: Latex Dry Fall; MPI #118.

a. Products:
1) Benjamin Moore Latex Dry Fall Flat 395 (MPI #118)
2) Sherwin-Williams Waterborne Acrylic Dryfall, Flat. (MPI #118)
3) Substitutions: Section 01 6000 - Product Requirements.

4. Top Coat Sheen:
a. Flat: MPI gloss level 1; use this sheen at exposedd ceiling.

5. Primer: As recommended by top coat manufacturer for specific substrate.

2.04 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

1. Alkali Resistant Water Based Primer - Structural Glazed Facing Tile and Hard Tile, Insulated Piping , Insulated Ductwork, and Concrete ; MPI #3.
a. Products:
1) Benjamin Moore Ultra Spec Int/Ext 100% Acrylic Sealer 608 (MPI #3)
2) Pittsburgh Paints Seal Grip Interior/Exterior Acrylic Universal Primer/Sealer, 17-921XI Series. (MPI #3)
3) Sherwin-Williams Loxon Concrete and Masonry Primer Sealer (Existing Brick), LX02W50. (MPI #3)
4) Sherwin Williams; PrepRite ProBlock Interior/Exterior Latex Primer/Sealer, B51-W60020 Series (MPI #3).
5) Substitutions: Section 01 6000 - Product Requirements.

2. Interior/Exterior Latex Block Filler; MPI #4.
a. Products:
1) Benjamin Moore Ultra Spec High Build Masonry Int/Ext Block Filler 571 (MPI #4)
2) Pittsburgh Paints Speedhide Masonry Hi Fill Latex Block Filler, 6-15XI . (MPI #4)
3) Sherwin-Williams PrepRite Interior/Exterior Latex Block Filler, B25W00025. (MPI #4)
4) Substitutions: Section 01 6000 - Product Requirements.

3. Interior Latex Primer Sealer - Gypsum Board; MPI #50.
a. Products:
1) Benjamin Moore Super Hide Zero VOC Interior Latex Primer 354 (MPI #50)
2) Pittsburgh Paints Pure Performance Interior Latex Sealer, 9-900. (MPI #50).
3) Sherwin Williams; ProMar 200 Zero VOC Interior Latex Primer, B28W02600 (MPI 50).
4) Substitutions: Section 01 6000 - Product Requirements.

4. Interior Rust-Inhibitive Water Based Primer (Aluminum and Non-Gavlanized Ferrous Metals); MPI #107.
a. Products:
1) Benjamin Moore Ultra Spec HP Acrylic Metal Primer HP04 (MPI #107)
2) Pittsburgh Paints Pitt-Tech Plus Interior/Exterior DTM Waterborne Acrylic Primer/Finish, 4020 PF Series.
3) Sherwin-Williams Pro-Cryl Universal Primer. (MPI #107)
4) Substitutions: Section 01 6000 - Product Requirements.

5. Interior Water Based Primer Galvanized Metal; MPI #134.
a. Products:
1) Benjamin Moore Ultra Spec HP Acrylic Metal Primer HP04 (MPI#134)
2) Pittsburgh Paints Pitt-Tech Plus Interior/Exterior DTM Waterborne Acrylic Primer/Finish, 4020 PF Series. (MPI #134)
3) Sherwin-Williams Pro-Cryl Universal Primer. (MPI #134)
4) Substitutions: Section 01 6000 - Product Requirements.

6. Stain Blocking Primer, Water Based; MPI #137.
a. Products:
1) Benjamin Moore High Hiding All Purpose Primer 046 (MPI #137)
2) Pittsburgh Paints Seal Grip Interior/Exterior Acrylic Universal Primer/Sealer, 17-921XI Series. (MPI #137)

3) Sherwin Williams; Multi-Purpose Latex, B51W00450 (MPI #137.
4) Substitutions: Section 01 6000 - Product Requirements.

7. Latex Primer for Interior Wood; MPI #39.
   a. Products:
      1) Benjamin Moore High Hiding All Purpose Primer 046 (MPI #39)
      2) Pittsburgh Paints Seal Grip Interior/Exterior Acrylic Universal Primer/Sealer, 17-921XI Series. (MPI #39)
      3) Substitutions: Section 01 6000 - Product Requirements.
8. Bonding Primer, Water Based for Dryfall; MPI #17.
   a. Products:
      1) Benjamin Moore High Hiding All Purpose Primer 046 (MPI #17)
      2) Pittsburgh Paints Seal Grip Interior/Exterior Acrylic Universal Primer/Sealer, 17-921XI Series. (MPI #17)
      3) Sherwin Williams, Multi-Purpose Latex Primer/Sealer B51W00450 (MPI #17).

2.05 CONCRETE STAINS AND SEALER

A. Drawing Designation: CONCS.
B. General:
   1. Locations:
      a. Use at following locations: Unless otherwise indicated, unfinished exposed concrete floors, equipment pads, ramps, steps, and stairs are to be finished using concrete stains.
C. Concrete Stains:
   1. I-TR-C: For traffic surfaces:
      a. Water-based, film forming, solid color, acrylic concrete stain; two coats.
         1) Benjamin Moore; Insl-X Tuffcrete WB Acrylic Waterproofing Concrete Stain, CST-2XXX; DFT 1.0 mils.
         2) H&C: H&C Colortop Water-Based Solid Color Concrete Stain; DFT As recommended by manufacturer.
         3) PPG; Perma-Crete Color Seal WB Interior/Exterior Concrete Stain, 4-4210XI Series, DFT 1.5 mils.
   2. Color: Clear.

2.06 ACCESSORY MATERIALS

A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
B. Patching Material: Latex filler.
C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin application of paints and finishes until substrates have been adequately prepared.
B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
E. Test shop-applied primer for compatibility with subsequent cover materials.
F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
   1. Gypsum Wallboard: 12 percent.
   2. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
   3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.02 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 repair existing paints or finishes that exhibit surface defects.
D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
E. Seal surfaces that might cause bleed through or staining of topcoat.
F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
G. Concrete:
    1. Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
    2. Prepare surface as recommended by top coat manufacturer and according to SSPC-SP 13.
H. Masonry:
    1. Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions. Allow to dry.
    2. Prepare surface as recommended by top coat manufacturer.
I. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
J. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
K. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
L. Galvanized Surfaces:
    1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
M. Ferrous Metal - Non-galvanized:
    1. Solvent clean according to SSPC-SP 1.
    2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
    3. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
        a. Re-prime entire shop-primed item.
    4. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning." Protect from corrosion until coated.
N. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
O. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.
P. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 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. Sand wood and metal surfaces lightly between coats to achieve required finish.

E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection.
B. Owner will provide field inspection.
C. Adhesion Test to be performed per ASTM D3359 Method A (5mils or less) or B (over 5mils)
D. All coatings shall be inspected as follows:
    1. Coatings shall be rejected for the following:
        a. Lacking minimum dry film thicknesses.
            1) Inspector may test for proper dry film thickness using methods as recommended by the inspector.
        b. Poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, and corners.
        c. Damage from touching, or disturbing paint in any other manner, before sufficiently dry.
        d. Damage from application to moist surfaces or damage caused by inadequate protection from the weather.
        e. Damage or contamination of paint from blown contaminants including but not limited to dust.
    2. Coatings shall be rejected if any of the following are evident under natural lighting for exterior surfaces and final lighting source, including daylighting, for interior surfaces:
        a. Visible defects are evident on vertical surfaces when viewed at normal viewing angles from a distance of not less than 48 inches.
        b. Visible defects are evident on horizontal surfaces when viewed at normal viewing angles from a distance of not less than 48 inches.
        c. Visible defects are evident on ceiling, soffit and other overhead surfaces when viewed at normal viewing angles from a distance of not less than 48 inches.
E. Visible defects are defined as follows:
    1. Brush and roller marks, streaks, laps, runs, sags, drips, heavy stippling, hiding or shadowing by inefficient application methods, skipped or missed areas, and foreign materials in paint coatings.
    2. When the final coat on any surface exhibits a lack of uniformity of color, sheen, texture, and hiding across full surface area.
F. Coatings rejected by the inspection shall be repaired or replaced at the expense of the Contractor.
G. Small affected areas shall be touched up.
    1. Large affected areas shall be repainted.
    2. Small and large areas shall be as defined by the Architect.
    3. Areas without sufficient dry film thickness shall be repainted.
    4. Paint runs and sags shall be removed by scraper or sanding and repainted.

3.05 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

A. Protect finishes until completion of project.
B. Touch-up damaged finishes after Substantial Completion.

3.07 SCHEDULE - PAINT SYSTEMS

A. Concrete, Concrete Masonry Units (CMU), Concrete Block, Brick Masonry: Finish surfaces exposed to view.
    1. Interior: CI-OP-3L, semi-gloss.
B. Gypsum Board: Finish surfaces exposed to view.

1. Interior Ceilings and Bulkheads: GI-OP-3L, flat.
2. Interior Walls: GI-OP-3L, eggshell.

C. Wood: Finish surfaces exposed to view.
1. Interior trim and frames: WI-OP-3L, semi-gloss.

D. Steel Doors and Frames: Finish surfaces exposed to view; MI-OP-MD-DT, semi gloss.

E. Steel Fabrications: Finish surfaces exposed to view.
1. Interior: MI-OP-3L, semi gloss.

F. Galvanized Steel: Finish surfaces exposed to view.
1. Interior: Mgl-OP-3L.

G. Shop-Primed Metal Items: Finish surfaces exposed to view.
1. Finish the following items:
a. Elevator pit ladders.
b. Exposed surfaces of steel stairs and railings.

H. Pipe and Duct Insulation Jackets: Finish surfaces exposed to view; FI-OP-3A, flat.

3.08 COLOR SCHEDULE

A. PT1/EP1
1. Sherwin Williams, Pure White, SW 7005

B. PT2/EP2
1. Sherwin Williams,.Custom Color to Match District Branding (Maroon)

C. PT3
1. Sherwin Williams, Custom Color to Match District Branding (Grey)

D. PT4
1. Sherwin Williams,Passive , SW 7064

END OF SECTION 09 9123

SECTION 10 0100 - MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fabric Banners
B. Graphic Frame System

1.02 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of products specified in this section with size, location and installation of service utilities.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general construction, material descriptions, finishes, dimensions and details.
C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, and installation details.
   1. Include plans, elevations, sections, details, and attachments to other Work.
   2. Include wiring diagrams of electrical components.
D. Samples:
   1. Submit 3 samples of each finish, 4 by 4 inch in size, minimum; illustrating color, finish, and texture.
E. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.
F. Test Reports: Show compliance to specified surface burning characteristics requirements.
G. Operation Data: Include normal operation, troubleshooting, and adjusting.
H. Maintenance Data: Include data on regular cleaning.
I. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least 5 years of documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package specified products as required to prevent damage before installation.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide manufacturers' standard warranties for material and workmanship.

PART 2 PRODUCTS

2.01 FABRIC BANNERS

A. Drawing Designation: FB1
B. Fabricators: Subject to compliance with requirements, provide banners by one of the following:
   1. Accent Banner; www.accentbanner.com, 800-367-3710
   2. Central Graphics & Signs; www.centralgraphicsgroup.com, 330-928-7080
   3. Rager Banners; www.ragar-banners.com, 800-844-8357
   4. Other approved fabricator.
C. Height:

1. Height at Lobby: 12 inches
2. Height at Corridor: 8 inches

D. Width: 48 inches, unless otherwise noted.

E. Performance Requirements:
1. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.

F. Fabric:
1. Manufacturer: Carnegie, Xorel
2. Style: Meteor 6427
3. Material: 100% IFR Xorel
4. Width: 56 inches
5. Substitutions: Not permitted.
6. Color:
   a. FB1-A: 2038 (Maroon)
   b. FB1-B: 769 (Black)
   c. FB1-C: 2001 (Grey)

G. Fabrication:
1. Fabric banners shall be fabricated with a top and bottom casing created by turning over hemmed fabric and stitching with 100% nylon or bonded monocord thread utilizing a #16, #18, or #22 needle. The casings shall be sized to receive a 1" diameter rigid aluminum tube at both top and bottom.
2. Side edges of banners shall be surged.
3. For ease of cutting, a "hot knife" shall be used as it fuses the ends of the fabric to minimize raveling.
4. Provide 1 inch diameter rigid aluminum tubes, top and bottom of each banner. Top tube shall be prepared to receive the eye hooks specified in next paragraph.
5. Banner top casings shall be cut, shaped, and hemmed to recieve a minimum of three (3) eye hooks that shall attach into the top rigid aluminum tube of each banner.
6. Bottom casings shall have velcro closures so that tubes can be inserted after transporting to job site and then casing closed off.

H. Suspension System
1. Provide eye hooks of appropriate size and strength to hold finished banners by attachment with braided cable to exposed ceiling construction above.
   a. Provide attachment clips for ceiling attachment similar to metal twists clip with eyelet: Caddy #4G16-H.

2.02 GRAPHIC FRAME SYSTEM

A. GFS Graphic Frame System: Wall mounted frame with spring-loaded pressure points and custom locking system.
1. Products:
   a. Clarus; Float Transition: https://www.clarus.com/float-transition/.
   b. Substitutions: Not Permitted.
   c. Manufacturer's Representative: Brad Betts, Great Lakes Architectural Products Group, 248.444.1664, brad@greatapg.com.
2. Graphic Size: 18"W x 12"H
3. Overall Frame Size: 22"W x 16"H
4. Frame Color: Black
5. Include all hardware required for mounting to CMU wall.

2.03 ACCESSORIES

A. Mounting Hardware: Provide all related fasteners and hardware required for a complete installation at substrates indicated.

B. Miscellaneous Trim and Accessories: Provide all trim and accessories required for a complete installation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as required by the specified products.
C. Verify that electrical service requirements are correct and properly located for specified products.

3.02 INSTALLATION

A. Install specified products in accordance with manufacturer's instructions.
B. Install specified products in locations indicated.
C. Install specified products level and plumb.

3.03 CLEANING

A. Clean specified products accordance with manufacturer's instructions

3.04 PROTECTION

A. Protect installed products from subsequent construction operations.

END OF SECTION 10 0100

SECTION 10 1100 - VISUAL DISPLAY UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Porcelain enamel steel markerboards.

1.02 REFERENCE STANDARDS

A. ASTM C208 - Standard Specification for Cellulosic Fiber Insulating Board; 2022.
B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's data on markerboard, tackboard, tackboard surface covering, trim, and accessories.
C. Shop Drawings: Indicate wall elevations, dimensions, joint locations.
   1. Include locations and layout of graphics.
   2. Include sections indicating trim profiles.
D. Samples:
   1. Markerboard Finishes: Submit two samples of each finish 2 by 2 inch in size illustrating finish, color, and texture.
   2. Composition and Natural Cork Sheet: Submit two samples of each finish, 2 by 2 inch in size illustrating finish, color, and texture.
   3. Fabrics: Submit two samples of each fabric, 8 by 10 inch inch in size illustrating color, finish, and texture.
   4. Trim: Submit two samples, 6 inches long, of each trim profile, including edge trim
E. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.
F. Test Reports: Show compliance to specified surface burning characteristics requirements.
G. Maintenance Data: Include data on regular cleaning, stain removal.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.
B. Installer Qualifications: Company experienced in installing the products specified in this section with minimum 5 years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package visual display boards as required to prevent damage before installation.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide Life of the building warranty for markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Visual Display Boards:
   1. ADP Lemco, Inc.; www.adplemco.com.
   2. ASI Visual Display Products, Inc., an ASI Group Company: www.asi-visualdisplayproducts.com.
   3. Claridge Products and Equipment, Inc: www.claridgeproducts.com/.
   4. Egan Visual, Inc.; www.egan.com.
   5. Ghent, a GMi company; www.ghent.com.
   6. Marsh Industries, Inc.; www.marsh-ind.com.
   7. Platinum Visual Systems; www.pvsusa.com.
   8. PolyVision Corporation: www.polyvision.com.

9. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.

2.03 VISUAL DISPLAY UNITS

A. Porcelain Enamel Steel Markerboards:
   1. Color: White.
   2. Sizes: As indicated on drawings.
   3. Frame: Extruded aluminum , with concealed fasteners.
   4. Accessories: Provide marker tray and map rail.
   5. Frame and Accessories Finish: Anodized, natural.

B. Combination Units and Units Made of More Than One Panel: Factory-assembled markerboards in a single frame, of materials specified above.
   1. Join panels of similar construction with butt joints, aligned and secured with steel spline concealed in edge of core.
   2. Configurations: As indicated on drawings.
   3. Units Too Large to Ship Assembled: Fully assembled in factory, then disassembled for shipping.

2.04 MATERIALS

A. Composition Cork Sheet: Seamless, homogeneous, self-sealing, plastic-impregnated, colored cork sheet.
   1. Construction: Granulated cork, linseed oil, resin binders, and dry pigments calendared on fabric backing; with integral color throughout. Washable surface.
   2. Color(s): Standard color(s) as selected by Architect.

B. Fiber Board: ASTM C208, cellulosic fiber board.

C. Adhesives: Type used by manufacturer.

2.05 TRIM AND ACCESSORIES

A. Frame Profile: Extruded aluminum. Manufacturer's standard J-trim.

B. Tack Strips: Extruded aluminum, manufacturer's standard profile, 1 inch wide, with cork insert.
   1. Cork Insert: Composition cork sheet.

C. Magnetic Marker Holder:
   1. Claridge; Stadium Maker Caddy, Large Plastic Magnetic Holder with Divider, MGM-MC1-L; www.claridgeproducts.com.
   2. Color: White
   3. Substitutions: See Section 01 6000 - Product Requirements.

D. Mounting Hardware: Concealed. Include brackets and all related fasteners and hardware required for a complete installation on substrates indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that internal wall blocking is ready to receive work and positioning dimensions are as instructed by the manufacturer.

3.02 INSTALLATION

A. Install boards in accordance with manufacturer's instructions.

B. Install visual display units in locations and at heights indicated.

C. Secure units level and plumb using adhesive and mechanical fasteners.
   1. Adhesive: Adhere units to substrates with adhesive placed in patches 16 inches on center each way.
   2. Fasteners: Mechanically attach units to substrates with concealed mounting brackets not more than 16 inches on center along tops and bottoms of units.
      a. Minimum of 2 fasteners at top and bottom of each board, or panel in a combination unit.

3. Where possible, locate wall fasteners at masonry and tile joints; do not penetrate masonry or tile faces.

D. Butt Joints: Install with tight hairline joints.

E. Install tack strips in locations and at heights indicated.

1. Install in longest lengths possible to minimize joints; align and tightly butt joints.
2. Fasteners: Concealed fasteners, 24 inches on center, minimum.

3.03 CLEANING

A. Clean board surfaces in accordance with manufacturer's instructions.

END OF SECTION 10 1100

SECTION 10 1400 - SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Vinyl graphics.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's data on each type of sign.
C. Shop Drawings: For each sign type, provide dimensioned elevation including letter sizes and locations, graphics, colors and finishes, mounting methods, mounting heights, and material descriptions.
D. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
   1. When room numbers to appear on signs differ from those on drawings, include the drawing room number on schedule.
   2. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
   3. Submit for approval by Owner through Architect prior to fabrication.
E. Samples:
   1. Room and Door Signs: Submit 3 samples of each type of sign construction, of size similar to that required for project, illustrating sign style, font, colors, and method of attachment.
   2. Dimensional Characters: Submit 3 samples, full size, of each dimensional character style, font, color, and method of attachment.
      a. For specified sizes 12 inches and under, provide samples matching specified size.
      b. For specified sizes over 12 inches, provide 12 inch high samples unless actual specified size requested by Architect.
   3. Plaques: Provide samples upon Architect's request.
F. Verification Samples: Submit samples showing colors specified.
   1. Where colors are not specified, submit two sets of color selection charts or chips.
G. Maintenance Data: Include data on regular cleaning.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Company experienced in installing the products specified in this section with minimum 5 years documented experience.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Package signs as required to prevent damage before installation.
B. Store tape adhesive at normal room temperature.

1.05 FIELD CONDITIONS

A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
B. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS

2.01 VINYL GRAPHICS

A. Drawing Designation: VG
B. Basis of Design:
   1. 3M Scotchcal Graphic Film for Textured Surfaces IJ8624; www.3m.com.
   2. Substitutions: See Section 01 6000-Product Requirements.
C. Film Type: Cast
D. Film Thickness: 2 mil
E. Imaging Method: Digital Print

F. Opacity: Opaque
G. Substrate: CMU
H. Surface Finish: Luster
I. Color: White
J. Locations: As indicated on drawings.
K. Size: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

A. General:
1. Install in accordance with manufacturer's instructions.
2. Clean surface, per manufacturer instructions, prior to installation of vinyl graphics.
3. Final cleaning of the substrate must be done immediatley before applying film. Dust and other contaminents will prevent the film from adhering properly.
4. Install neatly, with horizontal edges level.
5. Pressure-sensitive adhesive adheres to the substrate upon contact, even with only light finger pressure.
6. Film is not repositionable. Lifting the film typically causes it to stretch beyond use.
7. Do not lay graphic on the floor. It will pick up dirt on the back and transfer to substrate.
8. Test layout by temporarily positioning the graphic on the substrate. Use making tape to hold it in place. Ensure the graphic will fit and all the pieces are available.
9. Do not allow the edge of the graphic to fall on rivets.

END OF SECTION 10 1400

SECTION 10 1419 - DIMENSIONAL LETTER SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Dimensional letter signage.
B. Illumination system.

1.02 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
C. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. UL 879 - Electric Sign Components; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Manufacturer's product literature for each type of dimensional letter sign, indicating style, font, colors, locations, and overall dimensions of each sign.
C. Shop Drawings:
   1. Include dimensions, locations, elevations, materials, text and graphic layout, and attachment details.
   2. Show locations of electrical service connections.
   3. Include diagrams for power, signal, and control wiring.
D. Samples: Submit one sample of each type of dimensional letter sign of size similar to that required for project, indicating sign style, font, and method of attachment.
E. Selection Samples: Where materials, colors, and finishes are not specified, submit two sets of selection charts or chips.
F. Verification Samples: Submit samples showing colors and finishes specified.
G. Manufacturer's Installation Instructions: Include installation templates and attachment devices.
H. Manufacturer's qualification statement.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.
B. Installer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package dimensional letter signs as required to prevent damage before installation.
B. Store under cover and elevated above grade.
C. Store tape adhesive at a normal room temperature of 68 to 72 degrees F.

1.06 FIELD CONDITIONS

A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
B. Maintain minimum ambient temperature during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Dimensional Letter Signs:
   1. A.R.K. Ramos: www.arkramos.com/#sle.
   2. DMP Sign Co. (Formerly Detroit Marketing Products): www.dmpsignco.com
   3. Gemini Inc.: www.geminisignproducts.com.
   4. Inpro Corporation; _____: www.inprocorp.com/#sle.

5. Substitutions: See Section 01 6000 - Product Requirements.

2.02 REGULATORY REQUIREMENTS

A. Accessibility Requirements: Comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

2.03 DIMENSIONAL LETTERS

A. Applications: Interior.
   1. Use individual metal letters.
   2. Mounting Location: Exterior as indicated on drawings.

B. Metal Letters:
   1. Material: Aluminum casting.
   2. Thickness: Manufacturer's standard for letter size.
   3. Letter Height: As indicated on drawings.
   4. Text and Typeface:
      a. Character Font: Helvetica, Arial, or other sans serif font.
      b. Character Case: As indicated on drawings..
   5. Finish: 2-coat Flouropolomer or Powder Coated.
   6. Color: To match Architects sample.
   7. Mounting: Projected mount with collars.
   8. Illumination System: Halo-lit reverse channel letters.
      a. Provide products that are listed and labeled as complying with UL 879, where applicable.
      b. Power: 120 V, 60 Hz, 1 phase, 15 A.
   9. Products:
      a. A.R.K. Ramos; Metal Letters: www.arkramos.com/#sle.
      b. Substitutions: See Section 01 6000 - Product Requirements.

2.04 ACCESSORIES

A. Tape Adhesive: Double-sided tape, permanent adhesive.

B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70 by a qualified testing agency.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify that electrical service is correctly sized and located to accommodate dimensional letter signs.

C. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install with horizontal edges level.

C. Protect from damage until Date of Substantial Completion; repair or replace damaged items.

D. Protect from damage until mm-dd-yyyy; repair or replace damaged items.

END OF SECTION 10 1419

SECTION 10 2113.15 - FRP-CLAD TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. FRP-clad toilet compartments.
B. Urinal screens.

1.02 ABBREVIATIONS

A. FRP: Fiberglass reinforced plastic.

1.03 REFERENCE STANDARDS

A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2024.
B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
E. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).
F. ASTM D1622/D1622M - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.
G. ASTM D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics; 2017 (Reapproved 2023).
H. ASTM D2126 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging; 2020.
I. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2023, with Editorial Revision.
J. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2022.
K. ASTM D570 - Standard Test Method for Water Absorption of Plastics; 2022.
L. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; 2017.
M. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor; 2013a.
N. ASTM D5420 - Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact); 2016.
O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
P. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with placement of support framing and anchors in walls and ceilings.
   2. Coordinate the work with floor drain locations.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on panel construction, hardware, and accessories.
C. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall and floor supports, door swings.
   1. Indicate reinforcement locations for partition-mounted grab bars and surface-mounted toilet accessories.
   2. Show floor drain locations.
D. Samples:
   1. Submit 3 samples of partition panels, 6 by 6 inch in size illustrating panel finish, color, and sheen.

2. Submit 3 sample sets of hardware and accessories indicating material and finish; each set to include door latch, hinge, and panel bracket.

E. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.

F. Test Reports: Show compliance to specified surface burning characteristics requirements.

G. Maintenance Data: Include data on regular cleaning.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Door Hinges: Quantity equal to 2 percent of total installed, but not less than 4; including fasteners.
3. Door Latch, Strike, and Keeper: Quantity equal to 2 percent of total installed, but not less than 4; including fasteners.
4. Door Bumper: Quantity equal to 2 percent of total installed, but not less than 4; including fasteners.
5. Door Pull: Quantity equal to 2 percent of total installed, but not less than 2; including fasteners.
6. Fasteners: Quantity equal to 2 percent of each fastener type and size installed, but not less than 10 fasteners of each type and size.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.

B. Installer Qualifications: Company experienced in installing the products specified in this section with minimum 5 years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Package partition panels and material as required to prevent damage before installation.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide 10 year warranty against defects in workmanship and materials, including breakage and corrosion.

C. Provide limited lifetime warranty against failure of corner joinery, core deterioration, delamination or bubbling of panel skin, and fiberglass corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. FRP-clad Toilet Compartments:

1. Special-Lite, Inc.: www.special-lite.com.
2. Substitutions: Section 01 6000 - Product Requirements.

2.02 FRP-CLAD TOILET COMPARTMENTS

A. Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of FRP-clad foam core panels with extruded aluminum framing, floor-mounted headrail-braced.

1. Accessibility: Comply with ICC A117.1 and ADA Standards.
2. Surface Burning Characteristics:
   a. Class C per ASTM E84; flame spread 25, maximum, and smoke developed 450, maximum.

B. Panel Construction: Extruded aluminum perimeter framing with poured-in-place foam core and FRP face sheets.

1. Framing: Extruded aluminum, ASTM B221, alloy 6063, temper T5.
   a. Channel profile with integral reglets to accept FRP face sheet on both sides of panel.
      1) Channel shall secure face sheets in place with flush appearance.
      2) Provide mitered corners, mechanically fastened with stainless steel fasteners.
2. Foam Core: Poured-in-place foam.
   a. Manufacturer's standard polyurethane foam.

1) Density: 5 pcf; ASTM D1622/D1622M.
2) Compressive Strength: 60 psi; ASTM D1621.
3) Tensile and Tensile Adhesion Properties: ASTM D1623.
   (a) FRP Facer, 3 inches square: 53 psi, minimum.
   (b) FRP Facer, 5 inches square: 104 psi, minimum.
4) Thermal and Humid Aging: ASTM D2126; volume change at 158 degrees F and 100 percent humidity; 13 percent, maximum at 14 days.

3. Face Sheets: Fiberglass reinforced plastic (FRP).
   a. Thickness: 0.090 inch.
   b. Texture: Pebble grain.
   c. Color: Black.
   d. Performance:
      1) Flexural Strength: 8,500 psi, ASTM D790.
      2) Flexural Strength: 5,000 psi, ASTM D638.
      3) Barcol Hardness: 35, ASTM D2583.
      4) Izod Impact: 6 ft-lb per in, ASTM D256
      5) Gardner Impact Strength: 30 in-lb, ASTM D5420.
      6) Water Absorption: 0.16 percent, maximum after 24 hours at 77 degrees F, ASTM D570.
      7) Taber Abrasion Resistance: Taber test, CS-17 wheels, 1,000g weight, 25 cycles; 0.01 percent maximum weight loss.

C. Doors:
   1. Thickness: 1-1/4 inch.
   2. Width: 24 inch, unless otherwise indicated.
   3. Width for Handicapped Use: 36 inch, out-swinging, unless otherwise indicated.
   4. Height: 58 inch.

D. Panels:
   1. Thickness: 1-1/4 inch.
   2. Height: 58 inch.
   3. Widths: As indicated.

E. Pilasters:
   1. Thickness: 1-1/4 inch.
   2. Width: As required to fit space; minimum 3 inch.

F. Urinal Screens: Wall mounted with continuous panel brackets.
   1. Thickness: 1-1/4 inch.
   2. Width: 24 inches, unless otherwise indicated.
   3. Height: 42 inches, unless otherwise indicated.

2.03 ACCESSORIES

A. Pilaster Shoes: Formed aluminum ASTM B209, 4 inch high, concealing floor fastenings.
   1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.

B. Head Rails: Extruded anodized aluminum with anti-grip profile.

C. Wall, Pilaster, and Urinal Screen Brackets: Aluminum; continuous type.
   1. Provide full height T-shaped brackets at walls.
   2. Provide full height T-shaped brackets at urinal screens.
   3. Provide U and H-shaped brackets at all other locations.

D. Attachments, Screws, and Bolts: Stainless steel , tamper proof type.
   1. For attaching panels and pilasters to brackets: Through-bolts and nuts ; tamper proof.

E. Hardware:
   1. Continuous Hinges: Full mortise continuous aluminum hinge, gravity self-positioning.
   2. Door Latch: Aluminum strike and slide-type latch; surface-applied and through bolted.
      a. Latches shall have exterior emergency access feature.
   3. Doorstop: Manufacturer's standard hollow bulb type.
      a. Install full length door stop to pilasters; for outswinging doors, apply stop to door.

4. Door Pull: Manufacturer's standard pull; install on outswinging doors and all ADA/barrier free doors.
5. Coat hook with rubber bumper; one per compartment, mounted on door.

2.04 ALUMINUM FINISHES

A. Class I Natural Anodized Finish: Clear anodic coating; AAMA 611, minimum dry film thickness 0.7 mils.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify correct spacing of and between plumbing fixtures.
C. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
B. Maintain 3/8 inch to 1/2 inch space between wall and panels and between wall and end pilasters.
C. Align tops of doors and panels.
D. Attach panel brackets securely to walls using anchor devices.
E. Wall fasteners shall be located at masonry and tile joints; do not penetrate masonry or tile faces.
F. Align wall brackets and pilaster brackets.
G. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
H. Field touch-up of scratches or damaged finish will not be permitted. Replace damaged or scratched materials with new materials.

3.03 TOLERANCES

A. Maximum Variation From True Position: 1/4 inch.
B. Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING

A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.
C. Adjust adjacent components for consistency of line or plane.

END OF SECTION 10 2113.15

SECTION 10 2239 - FOLDING PANEL PARTITIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Top-supported folding panel partitions, horizontal opening.
   1. Manual paired panels.
   2. Motorized continuously hinged panels.
B. Self-supporting truss system.

1.02 REFERENCE STANDARDS

A. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
C. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
D. ASTM A513/A513M - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing; 2020a.
E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
H. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
I. ASTM E413 - Classification for Rating Sound Insulation; 2022.
J. ASTM E557 - Standard Guide for Architectural Design and Installation Practices for Sound Isolation Between Spaces Separated by Operable Partitions; 2012 (Reapproved 2020).
K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene at project site seven calendar days prior to scheduled beginning of construction activities of this section to review section requirements.
   1. Require attendance by representatives of installer.
   2. Notify Architect 5 business days in advance of scheduled meeting date.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on partition materials, operation, hardware and accessories, electric operating components, and track switching components.
C. Design Data: Design calculations, bearing seal and signature of structural engineer licensed to practice in the State in which the Project is located, showing loads at points of attachment to the building structure.
D. Shop Drawings: Indicate opening sizes, track layout, details of track and required supports, static and dynamic loads, adjacent construction and finish trim, and stacking depth.
   1. Include wiring diagrams of power and control wiring.
E. Samples:
   1. Fabric Finishes: Submit 3 samples of each fabric, 8 by 10 inch in size illustrating color, finish, and texture.
F. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.

G. Manufacturer's qualification statement.
H. Installer's qualification statement.
I. Operation and Maintenance Data: Operating procedures, troubleshooting and repair methods, wiring diagrams, parts lists, and identification of authorized maintenance firms located in vicinity of project.
J. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods. Describe cleaning materials detrimental to finish surfaces and hardware finish.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified this section with minimum 5 years of documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified and with at least 5 years of documented experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until installation.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Provide two year manufacturer warranty against defects in material and workmanship, excluding abuse.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Motorized Continuously Hinged Panels.
1. Hufcor, Inc.; Series 643E: www.hufcor.com.
2. Modernfold, a DORMA Group Company; Acousti-Seal 933E: www.modernfold.com.
3. Moderco, Inc.; Signature 843-E Series: www.moderco.com.
4. Substitutions: See Section 01 6000 - Product Requirements.
B. Self-supporting Truss System.
1. Hufcor, Inc.; Unispan Self Support System: www.hufcor.com.
2. Modernfold, a DORMA Group Company; Truss System: www.modernfold.com.
3. Substitutions: See Section 01 6000 - Product Requirements.
C. Folding Panel Partitions - Horizontal Opening: Basis of Design: Hufcore 643E Electrically opersated continuously hinged foldinbg partition.
1. Kwik-Wall Company; 2000 Series Operable Walls: www.kwik-wall.com/#sle.
2. Moderco, Inc; 800 Series Model 842: www.moderco.com/#sle.
3. Modernfold, a DORMA Group Company; AcoustiSeal 932: www.modernfold.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.
D. Self-supporting Truss System.
1. Kwik-Wall Company; Self Support System: www.kwik-wall.com
2. Modernfold, a DORMA Group Company; Truss System: www.modernfold.com.
3. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FOLDING PANEL PARTITIONS - HORIZONTAL OPENING

A. Folding Panel Partitions:
1. Motorized / Electrically Operated: Side-opening; continuous hinged panels; side stacking; motor operated.
B. Panel Construction:
1. Frame: 16 gauge, 0.0598 inch thick formed sheet steel frame top, bottom, jambs, and intermediates; welded construction, with acoustical insulation fill.
2. Panel Substrate Facing: Steel sheet, manufacturer's standard thickness.
3. Hinges: Panel manufacturer's standard continuous piano type.
4. Panel Properties:
a. Thickness Without Finish: 4 inches.

b. Width: Up to 48 inches (1219 mm).
c. Weight: 10 lb/sq ft.

C. Panel Finishes:
1. Facing: Fabric, 100 percent IFR Xorel.
2. Exposed Metal Trim: Standard Color to be Selected by Architect..

D. Panel Seals:
1. Panel to Panel Seals: Grooved and gasketed astragals, with continuous flexible ribbed vinyl seal fitted to panel edge construction; color to match panel finish.
2. Acoustic Seals: Flexible acoustic seals at jambs and ceilings, retractable floor seals.

E. Suspension System:
1. Track: Formed steel or extruded aluminum; thickness and profile designed to support loads.
a. Track shall provide support for adjacent ceiling materials.
b. Connect track to structural support with adjustable steel hanger brackets and 3/8 inch diameter threaded rods.
1) Hanger bracket thickness and profile designed to support track and associated loads.
c. Include all associated hardware and accessories.
2. Carriers: Nylon wheels on trolley carrier at top of every panel, sized to carry imposed loads, with threaded pendant bolt for vertical adjustment.

F. Performance Requirements:
1. Acoustic Performance:
a. Sound Transmission Class (STC): 50 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90, on panel size of 100 sq ft.
2. Surface Burning Characteristics of Panel Finish: Flame spread/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
3. Installed partition system track capable of supporting imposed loads, with maximum deflection of 1/360 of span.

G. Motorized/Electrically Operated Panels:
1. Electric Operator: 12 inches per second traveling speed; adjustable friction clutch brake actuated by solenoid controlled motor starter; enclosed limit switch; enclosed magnetic reversing starter.
2. Control Station: Onekey-operated (Open-Close-Stop), constant pressure type control device; 24 volt circuit; recess mounted.
a. Provide panel manufacturer's standard keyed switch.
3. Safety Features:
a. Limit Switches: Automatic type, at both extremes of travel, to prevent over-travel.
b. Emergency Release: Mechanism to disengage motor drive system and permit manual operation.
c. Pocket Door Interlock: Refer to pocket door specified in this section.
4. Electrical Requirements:
a. 1 hp, 4.5 rated load amperes; unless otherwise indicated or recommended by panel manufacturer.
b. 208 volts, three phase, 60 Hz; unless otherwise indicated or recommended by panel manufacturer.
c. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

H. Accessories:
1. Work Surfaces:
a. Markerboard: Bonded to panel face.
1) Material: Porcelain enameled steel sheet.
2) Size: Width of panel by 48 inches high.

3) Trim: Manufacturer's standard horizontal trim without exposed fasteners; for uninterrupted work surface, panel-to-panel, no vertical trim permitted.
4) Locations: As indicated.

b. Tackable Surface: Bonded to panel face.
1) Material: Polyester fabric over 1/4 inch natural cork sheet.
2) Size: Full width and height of panel.
3) Trim: Manufacturer's standard horizontal trim without exposed fasteners; for uninterrupted work surface, panel-to-panel, no vertical trim permitted.
4) Locations: As indicated.

2. Pocket Door/Enclosures: Manufacturer's standard pocket door, frame, and trim.
a. Same construction as panels.
b. Frame: Adjustable metal frame; flush design.
c. Hardware: Manufacturer's standard hardware including:
1) Hinges: 3, minimum.
2) Recessed operating hardware.
3) Keyed lock.
(a) Cylinder and core as specified in Section 08 7100 - Door Hardware.
d. Safety Features:
1) Pocket Door Interlock: Mechanism to prevent operation of panels unless storage pocket doors are fully open.
e. Factory finished to match partition panels.

3. Pass Door: Single door, 36 inch wide by 84 inch high opening; same design and construction as panel; fit door with perimeter acoustic gaskets, concealed closer, keyed lock, and tool operated floor seal. Frameless.
a. Hardware: Manufacturer's standard hardware including:
1) Hinges: 3, minimum.
2) Recessed operating hardware.
3) Keyed lock.
(a) Cylinder and core as specified in Section 08 7100 - Door Hardware.

2.03 SELF-SUPPORTING TRUSS SYSTEM

A. Self-Supporting Truss System: Manufacturer's standard, engineered, steel or aluminum, floor supported, sectional truss system designed to support folding panel partitions and track independent of building structure except for lateral bracing.
1. Configuration: Horizontal truss supported by vertical post at each end.
2. Fabrication:
a. Component Sizes: As engineered by truss system manufacturer.
b. Fabricate truss in sections for field assembly.
c. Design posts to be securely anchored to floor.
3. Provide lateral bracing to building's overhead structure at intervals recommended by truss system manufacturer; bracing size and configuration engineered by truss system manufacturer.

2.04 MATERIALS

A. Aluminum Extrusions: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
C. Steel Tubes: ASTM A500/A500M or ASTM A513/A513M, Type 5
D. Steel Sheet: Cold rolled commercial steel or structural steel; ASTM A1008/A1008M.
E. Fabric:
1. Products:
a. Carnegie; Xorel: https://carnegiefabrics.com/carnegie-xorel.
b. Substitutions: Not permitted.
2. Color/Pattern: Meteor 6427, 2001 (Grey).
3. Fiber Content: 100 percent IFR Xorel.
4. Width: 56 inches.
5. Backing: Unbacked.

F. Acoustic Insulation:
1. Type: Manufacturers standard.
2. Thickness: As required for acoustic performance indicated.

2.05 FINISHES

A. Steel and Aluminum Finishes: Manufacturer's standard powder coated paint.
1. Color: Standard color as selected by Architect.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that required utilities are available, of the correct characteristics, in proper location, and ready for use.
C. Verify floor flatness of 1/8 inch in 10 feet, non-cumulative.
D. Verify wall plumbness of 1/8 inch in 10 feet, non-cumulative.

3.02 INSTALLATION

A. Install partition in accordance with manufacturer's instructions and ASTM E557.
B. Install self-supporting truss system including lateral bracing in accordance with manufacturer's instructions.
C. Install components level and plumb.
D. Install electric operator, wiring, and controls. Locate control station(s) as indicated.
E. Fit and align partition assembly and pocket doors level and plumb.

3.03 ADJUSTING

A. Adjust partition assembly to provide smooth operation from stacked to full open position. Do not over-compress acoustic seals.
B. Visually inspect partition in full extended position for light leaks to identify a potential acoustical leak.
C. Adjust partition assembly to achieve lightproof seal.

3.04 CLEANING

A. Clean finish surfaces and partition accessories.

3.05 CLOSEOUT ACTIVITIES

A. Demonstrate operation of partition and identify potential operational problems.

END OF SECTION 10 2239

SECTION 10 2800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial toilet, shower, and bath accessories.
B. Electric hand dryers.
C. Utility room accessories.

1.02 ABBREVIATIONS AND ACRONYMS

A. CFCI: Contractor to Furnish, Contractor to Install.
B. OFCI: Owner to Furnish, Contractor to Install.

1.03 REFERENCE STANDARDS

A. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
D. ASTM B86 - Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings; 2023.
E. ASTM C1036 - Standard Specification for Flat Glass; 2021.
F. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2024.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with the placement of internal wall reinforcement and reinforcement of toilet partitions to receive anchor attachments.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
C. Samples: When requested by Architect.
    1. Submit 3 sample for each color and finish, 2 by 2 inch in size.
D. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.
E. Operation and Maintenance Data: Include operating procedures and recommended cleaning methods.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 6000 - Product Requirements, for additional provisions.
    2. Hand Dryer Filters: For units with filters, provide quantity equal to 2 filters per unit installed. .

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.
B. Installer Qualifications: Company experienced in installing the products specified in this section with minimum 5 years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Package toilet, bath, and laundry accessories as required to prevent damage before installation.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Mirrors: Provide 15 year warranty against silver spoilage.
C. Electric Hand Dryers: Provide 5 year warranty against defects in workmanship and materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design:
   1. Commercial Toilet, Shower, and Bath Accessories, including Utility Room Accessories: Provide product indicated or a comparable product by one of the following:
      a. American Specialties, Inc, (ASI): www.americanspecialties.com.
      b. Bobrick Washroom Equipment, Inc.: www.bobrick.com.
      c. Bradley Corporation: www.bradleycorp.com.
      d. Substitutions: Section 01 6000 - Product Requirements.
   2. Electric Hand Dryers: Provide product indicated or a comparable product by one of the following:
      a. Excel Dryer Inc.: www.exceldryer.com.
      b. Substitutions: Section 01 6000 - Product Requirements.

2.02 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
B. Keys: Provide 2 keys for each accessory to Owner; master key lockable accessories.
C. Stainless Steel Sheet: ASTM A666/A666M, Type 304.
D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
F. Zinc Alloy: Die cast, ASTM B86.
G. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
H. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.
I. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.03 FINISHES

A. Stainless Steel: Satin finish, unless otherwise noted.

2.04 COMMERCIAL TOILET ACCESSORIES

A. Toilet Paper Dispenser - Bracket Type: Double roll, surface mounted bracket type, stainless steel, eccentric-shaped plastic spindle for 1/2 revolution delivery designed to prevent theft of tissue roll.
   1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-2740.
B. Paper Towel Dispenser - Folded Paper Type: Folded paper type, stainless steel, surface-mounted, with viewing slots on sides as refill indicator and tumbler lock.
   1. Capacity: 400 C-fold or 500 multifold minimum.
   2. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-262.
C. Soap Dispenser - Wall-Mounted: Liquid soap dispenser, wall-mounted, surface, with stainless steel cover and vertical stainless steel tank and working parts; push type soap valve, check valve, and window gauge refill indicator, tumbler lock.
   1. Minimum Capacity: 40 ounces.
   2. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-2111.
D. Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.
   1. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
   2. Size: As indicated on drawings.
   3. Frame: Angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.

4. Backing: Full-mirror sized, minimum 0.03 inch galvanized steel sheet and nonabsorptive filler material.
5. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-290.

E. Grab Bars: Stainless steel, smooth surface.
1. Standard Duty Grab Bars:
a. Push/Pull Point Load: 250 pound-force, minimum.
b. Dimensions: 1-1/2 inch outside diameter, minimum 0.05 inch wall thickness, concealed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
c. Finish: Satin, slip-resistant surface.
d. Length and Configuration: As indicated on drawings.
e. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-6806 Series.

F. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, removable receptacle.
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-270.

2.05 ELECTRIC HAND DRYERS

A. Electric Hand Dryers: High Speed, high performance hand dryer, with downward fixed nozzle.
1. Operation: Automatic, sensor-operated on and off.
2. Mounting: Surface mounted.
a. Maximum Projection From Wall: 4 inches.
3. Cover: Stainless steel with brushed finish.
a. Tamper-resistant screw attachment of cover to mounting plate.
b. Screened or shielded air intake.
c. Screen or shield to prevent access to motor/heater.
4. Air Flow: 60 CFM, minimum.
5. Air Velocity: 16,000 linear feet per minute, minimum, at full power.
6. Fan/Heater Control: Field adjustable fan speed and heater on/off selection.
7. Noise: 75dB, maximum, 72 inches from unit; with hands under nozzle.
8. Total Wattage: 1500 W, maximum.
9. Runtime: Field adjustable, from approximately 10 seconds to approximately 35 seconds.
10. Supply Voltage: 240 V, single phase, 60 Hz, nominal, unless otherwise indicated.
11. Warranty: 5 years.
12. Filtere: HEPA Filtration System.
13. Noise Reduction Nozzle 1.1N
14. Basis-of-Design Product: Excel Dryer Inc.; Xlerator
a. Substitutions: Not permitted

2.06 UTILITY ROOM ACCESSORIES

A. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, with 1/2 inch returned edges, 0.06 inch steel wall brackets.
1. Drying rod: Stainless steel, 1/4 inch diameter.
2. Hooks: Three, 0.06 inch stainless steel rag hooks at shelf front.
3. Mop/broom holders: Four spring-loaded rubber cam holders at shelf front.
4. Length: 36 inches.
5. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-224.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify exact location of accessories for installation.

3.02 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
B. Install plumb and level, securely and rigidly anchored to substrate.
C. Mounting Heights: As indicated and as required by accessibility regulations.

D. Where possible, locate wall fasteners at masonry and tile joints; do not penetrate masonry or tile faces.

3.03 PROTECTION

A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 2800

SECTION 10 4400 - FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire extinguishers.
B. Fire extinguisher cabinets.

1.02 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.
B. NFPA 10 - Standard for Portable Fire Extinguishers; 2026.
C. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide extinguisher operational features, extinguisher ratings and classifications, color and finish, and anchorage details.
C. Shop Drawings: Indicate locations of cabinets, cabinet physical dimensions, rough-in measurements for recessed cabinets, locations of individual fire extinquishers, mounting measurements for wall bracket, and accessories required for complete installation.
D. Samples: When requested by Architect.
   1. Submit 3 sample for each color and finish, 2 by 3 inch in size.
E. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.
F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.
B. Installer Qualifications: Company experienced in installing the products specified in this section with minimum 5 years documented experience.

1.05 FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Fire Extinguishers: 5 year warranty against defects in workmanship and materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguishers:
   1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com.
   2. Croker Division of Fire-End and Croker Corp.: www.croker.com.
   3. Larsen's Manufacturing Co: www.larsensmfg.com.
   4. Nystrom, Inc: www.nystrom.com.
   5. Potter-Roemer: www.potterroemer.com.
   6. Substitutions: See Section 01 6000 - Product Requirements.
B. Fire Extinguisher Cabinets and Accessories:
   1. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com.
   2. Croker Division of Fire-End and Croker Corp.: www.croker.com.
   3. Larsen's Manufacturing Co: www.larsensmfg.com.
   4. Nystrom, Inc: www.nystrom.com.
   5. Potter-Roemer: www.potterroemer.com.
   6. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   1. Provide extinguishers labeled by UL (DIR) or testing firm acceptable to authorities having jurisdiction for purpose specified and as indicated.

B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
   1. Class: A:B:C type.
   2. Size: 10 pound.
      a. UL Rating: 4A-60B:C.
   3. Finish: Baked polyester powder coat, red color.
   4. Minimum Operational Temperature: Minus 65 degrees F.

2.03 FIRE EXTINGUISHER CABINETS

A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.

B. Cabinet Construction: Non-fire rated.
   1. Formed primed steel sheet; minimum 0.036 inch (20 gage) thick base metal.

C. Fire Rated Cabinet Construction: Fire rating equal to wall in which installed.
   1. Primed steel; double wall or outer and inner boxes with 5/8 inch thick fire barrier material.
      a. Minimum Thickness: 0.036 inch (20 gage).

D. Cabinet Configuration: Recessed and semi-recessed type.
   1. Size to accommodate fire extinguisher.
   2. Trim - Recessed Cabinets: Flat square edge, with minimum 1-3/4 inch wide face. Stainless steel.
   3. Projected Trim - Semi-Recessed Cabinets: Returned to wall surface, with 2-1/2 inch rolled-edge projection, and 1-3/4 inch wide face. Stainless steel.
   4. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim.

E. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with roller type catch. Hinge doors for 180 degree opening with continuous piano hinge.
   1. Metal: Stainless steel.

F. Door Glazing: Tempered glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.
   1. Style: Vertical duo panel glazing.

G. Door Pull: Manufacturer's standard flush/recessed pull handle.

H. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.

I. Fabrication: Weld, fill, and grind components smooth.

J. Finish of Cabinet Exterior Trim and Door: No. 4 - Brushed stainless steel.

K. Finish of Cabinet Interior: White; powder coat.

2.04 ACCESSORIES

A. Extinguisher Brackets: Formed steel, painted black. Sized for fire extinguishers specified.

B. Lettering: “FIRE EXTINGUISHER” diecut self-adhering black, equally spaced, lettering; provide in accordance with authorities having jurisdiction (AHJ).
   1. Locations: Unless otherwise indicated:
      a. Fire Extinguisher Cabinets: Locate on door.
         1) Lettering shall be applied at the factory.
      b. Wall brackets: Locate above fire extinguisher and bracket.
   2. Orientation: Vertical.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install cabinets and fire extinguisher brackets plumb and level at mounting heights indicated and in accordance with authorities having jurisdiction (AHJ).
C. Secure rigidly in place.
D. Place extinguishers in cabinets and on wall brackets.
E. Apply fire extinguisher lettering to walls above wall bracket mounted fire extinguishers in accordance with authorities having jurisdiction (AHJ).
F. Adjust cabinet doors for smooth operation.

3.03 PROTECTION

A. Protect installed fire protection specialties from damage due to subsequent construction operations.

END OF SECTION 10 4400

SECTION 10 5129 - PHENOLIC LOCKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Phenolic lockers.

1.02 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's published data on locker construction, sizes and accessories.
C. Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code.
D. Samples: Submit two samples 3 by 6 inches in size, of each color scheduled.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Phenolic Lockers:
   1. Summit Lockers, Inc: www.summitlockers.com/#sle.
   2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 LOCKER APPLICATIONS

A. L-1 Open-Front Cubbies: Phenolic lockers, wall mounted with matching closed base.
   1. Width: 24 inches.
   2. Depth: 18 inches.
   3. Height: 24 inches, including base and solid surface seat. Refer to drawings.
   4. Locker Configuration: Single tier.
   5. Fittings: Size and configuration as indicated on drawings.
   6. Provide matching closed base.
   7. Solid Surface (SS1) seat to be applied on bench top. Refer to spec section 06 4023.

2.03 PHENOLIC LOCKERS

A. Lockers: Factory assembled, made of phenolic core panels with mortise and tenon joints and stainless steel mechanical joint fasteners; fully finished inside and out; each locker capable of standing alone.
   1. Panel Core Exposed at Edges: Machine polished, without chips or tool marks; square edge unless otherwise indicated.
   2. Where locker ends or sides are exposed, finish the same as fronts or provide extra panels to match fronts.
   3. Body Color: Manufacturer's standard white or light color.
   4. Fasteners for Accessories and Locking Mechanisms: Tamperproof type.
B. Component Thicknesses:
   1. Locker Body: One of the following combinations:
C. Phenolic Core Panels: Nonporous phenolic resin and paper core formed under high pressure, with natural colored finished edges, integral melamine surface, matte finish, and uniform surface appearance; glued laminated panels not acceptable.
   1. Surface Burning Characteristics: Flame spread index of 75 or less, and smoke developed index of 450 or less; when tested in accordance with ASTM E84.
D. Number Plates: Manufacturer's standard, minimum 4-digit, permanently attached with adhesive; may be field installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared bases are in correct position and configuration.

B. Verify bases and embedded anchors are properly sized.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Place and secure on prepared base.
C. Install lockers plumb and square.
D. Secure lockers with anchor devices to suit substrate materials. Minimum Pullout Force: 100 pounds.
E. Bolt adjoining locker units together to provide rigid installation.
F. Install end panels and filler panels.
G. Install accessories.
H. Replace components that do not operate smoothly.

3.03 CLEANING

A. Clean locker interiors and exterior surfaces.

END OF SECTION 10 5129

SECTION 11 6623 - GYMNASIUM EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Basketball equipment.
B. Wall safety pads.
C. Divider curtains.
D. Indoor batting cages.
E. Volleyball equipment.

1.02 DEFINITIONS

A. NFHS: National Federation of State High School Associations.

1.03 REFERENCE STANDARDS

A. ANSI A208.1 - American National Standard for Particleboard; 2022.
B. ASTM A391/A391M - Standard Specification for Grade 80 Alloy Steel Chain; 2021.
C. ASTM A413/A413M - Standard Specification for Carbon Steel Chain; 2021.
D. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
E. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
G. ASTM F2440 - Standard Specification for Indoor Wall/Feature Padding - 2018.
H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
I. NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.
J. NFHS (Guide) - Court and Field Diagram Guide; current edition.
K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
L. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
M. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films; 2023, with Errata.
N. PS 1 - Structural Plywood; 2023.
O. PS 2 - Performance Standard for Wood Structural Panels; 2018.

1.04 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. Large Components: Ensure that large components can be moved into final position without damage to other construction.
C. Electrically Operated Equipment: Coordinate location and electrical characteristics of service connection.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's data showing configuration, sizes, materials, finishes, hardware, and accessories; include:
   1. Electrical characteristics and connection locations.
C. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Include point loads and locations for attachment of gymnasium equipment to structure.
   3. Indicate operational clearances.
   4. Include diagrams for power, signal, and control wiring

5. For divider curtains:
   a. Include plans showing alignment of curtains in relation to court layout and overhead structural supports.
   b. Include system clearances, stacking requirements, and limits for fitting into adjacent construction.

D. Coordination Drawings: Court layout plans, reflected ceiling plans, and other details, drawn to scale, and coordinated with ceiling-suspended gymnasium equipment, divider curtains, floor inserts, game lines, and markers applied to finished flooring, and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which overhead-supported gymnasium equipment will be attached.
   2. Suspended ceiling components, if any.
   3. Items supported from building structure above the courts, including, but not limited to, the following:
      a. Luminaires.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Smoke detectors.
      f. Acoustical treatments or panels.
      g. Access panels.

E. Samples: Submit 3 samples 3 by 3 inches in size showing each color and finish selected.

F. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.

G. Operating and maintenance data for each operating equipment item.

H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 5 years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified with minimum 5 years of documented experience and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project site in manufacturer's original packaging with factory original labels attached.

B. Store products indoors and elevated above floor; prevent warping, twisting, or sagging.

C. Store products in accordance with manufacturer's instructions; protect from extremes of weather, temperature, moisture, and other damage.

1.08 FIELD CONDITIONS

A. Environmental Limitations: Do not install equipment until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Verify position and elevation of floor inserts and layout for gymnasium equipment.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer agrees to repair or replace components of gymnasium equipment that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Basketball backboard failures, including glass breakage.
      b. Faulty operation of divider curtains and basketball backstops.
      c. Faulty operation of volleyball standards and winches.

2. Warranty Periods:
   a. 1 year from date of Substantial Completion for volleyball nets, volleyball referee stand, volleyball equipment cart, safety pads, volleyball antennas, volleyball sideline markers, and volleyball cable covers.
   b. 3 years from date of Substantial Completion volleyball winch assembly, volleyball floor sleeves, and volleyball cover plates.
   c. 4 years from date of Substantial Completion for basketball goals.
   d. 5 years from date of Substantial Completion for divider curtains.
   e. 10 years from date of Substantial Completion for basketball backboard safety pads and volleyball standards.
   f. 25 years from date of Substantial Completion for ceiling mounted basketball backstops.
   g. Lifetime for basketball backboards.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Gymnasium Equipment: The design for each item specified is based on the product name. Provide either the product identified as "Basis of Design" or an equivalent product from one of the following:
   1. ADP Lemco, Inc: www.adplemco.com/#sle.
   2. Draper, Inc: www.draperinc.com/#sle.
   3. IPI by Bison, Inc: www.ipibybison.com/#sle.
   4. JayPro Sports, LLC; www.jayprosports.com.
   5. Performance Sports Systems: www.perfsports.com/#sle.
   6. Porter Athletic Equipment Company: www.porterathletic.com/#sle.
   7. Spalding Sports Equipment; www.spaldingequipment.com
   8. Shelde Sports ; www.scheldesports.us; (833) 724-3533.
   9. Substitutions: See Section 01 6000 - Product Requirements.

2.02 GENERAL REQUIREMENTS

A. See drawings for sizes and locations, unless noted otherwise.
B. Where mounting dimensions or sizes are not indicated, comply with applicable requirements of the following:
   1. National Federation of State High School Associations (NFHS) sports rules; NFHS (Guide).
C. Provide mounting plates, brackets, and anchors of sufficient size and strength to securely attach equipment to building structure; comply with requirements of Contract Documents.
   1. Equipment supplier / Installer to provide all required support pipes, hangers, chains, cables, etc., to install their products from the main structure. Equipment cannot be mounted to secondary roof purlins.
D. Hardware: Heavy duty steel hardware, as recommended by manufacturer.
E. Electrical Wiring and Components: Comply with NFPA 70; provide UL-listed equipment.
F. Structural Steel Fabrications: Welded in accordance with AWS D1.1/D1.1M, using certified welders.

2.03 GYMNASIUM DIVIDER CURTAINS

A. Netting: Fixed.
   1. Netting: Black; No. 36 Nylon
      a. Mesh openings: 1 3/4 inch square.
   2. Color> Black
B. Divider-Curtain System: Electrically operated.
   1. Operation: Vertical lift fold-up conforming to ceiling profile;
   2. Outer Edge Hems: Double turned and welded.
   3. Supports and Fittings: Corrosion-resistant steel clamps and hangers.
   4. Drive Pipe: 3-1/8-inch nominal diameter, fabricated from steel or aluminum, with minimum number of joints for required lengths. Black finish.

5. Curtain Battens: 1-1/2-inch nominal diameter, fabricated from steel pipe or tubing, with minimum number of joints for required lengths. Black finish.

C. Divider Curtains:
1. Upper Curtain, Mesh: Woven mesh of polyester yarn coated with vinyl, weighing not less than 9 oz./sq. yd.
a. Color: Standard color as selected by Architect.
2. Lower Curtain, Solid: Woven polyester fabric coated with vinyl, 22 oz./sq. yd.
a. Height Above Floor: 8 feet.
b. Color: Standard color as selected by Architect.
3. Hems: Folded and electronically welded.
4. Seams: Electronically welded.
5. Overall Curtain Height: Floor to ceiling, within installation clearances required.
6. Bottom of Curtain: Approximately 2 inches above finished floor.
7. Flame-Resistance Rating: Passes NFPA 701 Test 2.

D. Curtain Operators:
1. Electric motors of size and capacity recommended by divider curtain manufacturer for proper operation.
a. Include wiring from control stations to motors and between synchronizer and dual motors for long curtains.
b. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
2. Electrical Components, Devices, and Accessories: Listed and labeled according to NFPA 70 and marked for intended location and application.
3. Motor Electrical Characteristics:
a. Horsepower: 1 hp.
b. Voltage: 120 V AC, single phase, 60 hertz.
4. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop divider curtain at fully extended and fully retracted positions.
5. Safety Lock: Locks drive system when speed exceeds 1-1/2 fps or manufacturer's recommended speed; whichever is more restrictive.
6. Controls: Controlled by a remote control station.

E. Locations: As indicated.

F. Basis of Design: Refer to Drawings for locations of the following types: .
1. Divider Curtain: Performance Sports Systems; Model Peak Fold 4025-Peak: www.perfsports.com
2. Divider Curtain: Performance Sports Systems; Model Slope Fold 4025-Slope: www.perfsports.com
3. Divider Curtain: Performance Sports Systems; Model 4030 Roll Up; www.perfsports.com
4. Walk Draw Curtain: Performance Sports Systems; Model 4013: www.perfsports.com
5. Walk Draw Curtain:

2.04 INDOOR CONTAINMENT

A. Indoor Batting Cages:
1. Enclosure Material: Netting on top and sides with sewn rope border allowing for additional material on sides to rest on floor to retain balls within batting cage.
2. Netting: Black, No.36 nylon, 1-3/4 inches square.
3. Size:
a. Length:70 feet.
b. Width: 12 feet.
c. Height: 12 feet.
4. Upper Support Frame: At least 1-1/2 inches diameter aluminum pipe and necessary fittings to provide symmetrical layout with uniform spacing.
5. Support Cables: Steel cables at least 1/8 inch in diameter with minimum of 1800 pounds tensile strength spaced to align with support frame horizontal members providing uniform load distribution and stability.

6. Basis of Design: Performance Sports Systems; Model 4080BL - 70: www.perfsports.com

B. Indoor Suspended Throwing Cage:
1. Enclosure Material: Netting on top and sides with sewn rope border allowing for additional material on sides to rest on floor to retain balls within batting cage.
2. Netting: Black, No.36 nylon, 1-3/4 inches square.
3. Width: 16 feet 5 inches
4. Radius: 8 feet 2 1/2 inches
5. Height: 12 feet 2 inches
6. Basis of Design: Performance Sports Model 4075

2.05 FLOOR-MOUNTED EQUIPMENT

A. Sleeves for Volleyball Posts:
1. Manufacturer: Shelde Sports:
2. Size:
a. Diameter: 3 inches
b. Length: 9 inches
c. Flange thickness: 1/8 inch.
3. Cover:
a. Material: Brass alloy construction
1) Provide spacesrs to accommodate distance between finished floor level and cast in places sleeve body.
b. Color: Painted to match color sample provided by Architect.

2.06 WALL SAFETY PADS

A. Wall Safety Pads: Padded wall panels attached in a continuous row.
1. Construction: Fabric covered fill material laminated to backer board,
a. Backer Board: Minimum 1/2 inch thick plywood or oriented strand board.
b. Fill: Fire-resistive, high impact-resistant, neoprene foam.
1) Thickness: 2 inches, minimum.
2) Density: 6 lb per cu. ft.
c. Fabric: Puncture and tear resistant, PVC-coated polyester or nylon-reinforced PVC fabric.
1) Weight: 14-oz./sq. yd., minimum.
2) Secure fabric to back of backer board.
3) Fabric shall be free of sags and wrinkles.
4) Treat with fungicide for mildew resistance.
5) Colors: Two standard colors as selected by Architect.
2. Performance Requirements:
a. Complies with ASTM F2440 for impact protection.
b. Surface-Burning Characteristics: ASTM E84, Class A.
1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 450 or less.
3. Sizes:
a. Standard Padding:
1) Width: 24 inches.
2) Length: 72 inches.
b. L and C Shaped Padding:
1) Manufacturer's standard L and C shapes for corners. Length to match standard padding.
c. Specially Shaped Padding: Custom fabricate special shapes and sizes to fit irregularly shaped members, areas, and protrusions in walls.
1) Provide padding for:
(a) I-beams.
(b) Pilasters / Columns
(c) Other items as indicated.

4. Cutout Trim: Provide manufacturer's standard flanged cutout trim kits for fitting pads around switches, receptacles, and other obstructions.
5. Mounting Method: Concealed Z-clips.
6. Locations: As indicated.
7. Basis-of-Design: Performance Sports Systems; Model 4130 Wall Pads with Model 4196 z-clips.

2.07 REMOTE CONTROL SYSTEM

A. Remote Control System:
1. General: All gymnasium operable equipment within each gymnasium space shall be controlled from a single system located within full view of all the operable gymnasium equipment.
   a. Systems shall be capable of controlling all the operable equipment within the space including, but not limited to, the following:
      1) Divider curtains.
      2) Batting cages
      3) Throwing cages
   b. Provide two (2) separate control systens as follows:
      1) One to control Divider Curtains and containment items on the first levelk.
      2) One to control the Batting Cages on the Mezzanine Level (Alternate No. 1)
2. Remote-Control Stations: NEMA IA 10030, Type 1 enclosure for flush mounting. Key-pad controlled, with constant pressure on the key pad to control gymnasium equipment.
   a. Control station shall be capable of controlling gymnasium equipment individually or in multiple pre-programmed groups.
   b. Control station shall require a four digit password to operate and shall go inactive after 30 seconds of non-use.
   c. Control station shall use LED lights and buzzer, or similar method, to provide information to user as follows:
      1) Green LED and buzzer activation occurs after correct password has been entered, and system is activated.
      2) Yellow LED indicates standby mode.
      3) Red LED indicates activation and operation of selected gymnasium equipment.
   d. Locations: As indicated.
3. Include all associated relay boards and wiring as required for a complete remote control system.
4. Basis-of-Design: Performance Sports Systems; Model TSC1500.

2.08 MISCELLANEOUS MATERIALS

A. Cheer Mat: EZ Flex Carpet Bonded Foam Mat; www.ezflexmats.cpom
1. Foam Type: Cross-Linked Polyethylene
2. Thickness: 2 inches
3. Size: 6 feet wide x 43 long feet.
4. Quantity: Seven (7) for total width of 42 feet.
5. Color: Selected by Architect from standard range

B. JumpForm Sand Pit: Sports Specialties: www.sportsfield.com
1. Model: SPSCHS
2. Size:
   a. Interior length: 23 feet, 5 1/4" inches.
   b. Exterior length: 26 feet 4 inches
   c. Width: 13
3. Provide Standard cover consisting of eight (8) panels.
4. Provide 1/8 inch aluminum sheet sand catchers complete with:
   a. 1/8 inch Aluminum sheet base forms with welded cross supports.
   b. Integrated drain tubess at each corner.
   c. 1 inch x 1/8 inch thick aluminum swag grating,
   d. q.2 inch thick rubber mats with 1 1/4 inch round perforations.

5. Provide 8 inch Take off Board, complete with:
   a. 3/4 inch white polyboard stextured surface (Replacable).
   b. Extruded spacer
   c. Stainless steel trough connected to sub-surgace drainage stystem.

C. Vault Box Plug:
   1. Sportsfield Specialties: Model PVBCPSS
      a. Material:
         1) Aluminum.
         2) Thickness: 0.090 inches.
         3) Depth: Tapered from 0 inches to 7 3.4 inches.
         4) Width: 1 foot 11 9/16 inches.
         5) Length: 3 feet 6 3/16 inches.
      b. Cover recessed 1/2 inch to receive synthetic track materia, and provided with retractable lift handle..
      c. Provide:
         1) Pole Vault Uprights:
            (a) Model: PVS0517 (two).
               (1) Frame: Custom Extruded Uprights with 1 1/2 inch square tune extension post,1/8" thick wall construction.
               (2) Steel rolling base
               (3) Bar rest pins
            (b) Cross Bar positions 5 feet to 17 feet.
         2) Provide Cross bar
            (a) Model PVX
            (b) Length: 13 feet 1 inch.
            (c) Material: High strength, High visability Fiberglass.
         3) Provide fall mats full set with 2 color logo
            (a) Model: PV2224HDZ Durazone
               (1) PVDG - Digitally printed grapgic.
               (2) Artwork to be provided by Architect.
         4) Provide Pole Vault Standard Angled Base Protector Pads for uprights: Model PVBPANG

D. Wrestling Mat: EZ Flex Carpet Bonded Foam Mat: www.ezflexmats.com
   1. Foam Type: Cross linked Polyethylene.
   2. Thickness: 2 inches.
   3. Size: 6 feet wide x 42 feet long.
   4. Quantity: Seven (7) for a total width of 42 feet.
   5. Color: Selected by Architect from standard range.
   6. Logo: Provide 2 color logo for center of the combined matt layout.
      a. Artwork for logo to be provided to Contractor.

E. Equipment-Mounting Boards: Wood; size and quantity as required to mount gymnasium equipment according to manufacturer's instructions.
   1. Finish: Gymnasium equipment manufacturer's standard transparent finish.

F. Associated Hardware, Support, and Fasteners:
   1. Support Cable: Manufacturer's standard galvanized-stranded-steel wire rope with a breaking strength of 7000 lbs.
      a. Provide fittings according to the wire rope manufacturer's instructions for size, number, and installation method.
   2. Support Chain and Fittings: ASTM A391/A391M, Grade 80, heat-treated alloy-steel chains.
      a. Provide hot-dip galvanized or zinc-plated steel connectors and hangers.
   3. General Purpose Chain: For chains not used for overhead lifting, ASTM A413/A413M carbon steel chain, Grade 30 proof coil chain or higher as recommended by gymnasium equipment manufacturer.

a. Provide coating type, chain size, number, and installation method according to manufacturer's instructions.

4. Castings and Hangers: ASTM A47/A47M malleable iron; grade as required for structural loading.
5. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard corrosion-resistant units; concealed; tamperproof, vandal-resistant design.

G. Plywood: PS 1, Exterior Exposure.
H. Oriented Strand Board (OSB): PS 2.
I. Particle Board: ANSI A208.1.
J. Grout: Nonshrink, nonmetallic, premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, ASTM C1107/C1107M; with minimum strength recommended by gymnasium equipment manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Take field measurements to ensure proper fitting of work. If taking field measurements before fabrication will delay work, allow for adjustments within recommended tolerances.
B. Inspect areas and conditions before installation, and notify Architect in writing of unsatisfactory or detrimental conditions.
1. Verify that supporting structure, subfloors, and other substrates are properly prepared to receive and support work of this section.
C. Do not proceed with this work until conditions have been corrected; commencing installation constitutes acceptance of work site conditions.
D. Verify that electrical services are correctly located and have proper characteristics.

3.02 INSTALLATION - GENERAL

A. Install gymnasium equipment in accordance with Contract Documents and manufacturer's instructions.
B. Install gymnasium equipment after other finishing operations, including painting, have been completed unless otherwise indicated.
C. Coordinate installation of inserts and anchors that must be built in to flooring or subflooring.
D. Install equipment rigid, straight, plumb, and level.
E. Secure equipment with manufacturer's recommended anchoring devices.
1. Fasteners and anchors shall properly transfer gymnasium equipment loads to structural supports.
F. Separate dissimilar metals to prevent electrolytic corrosion.
G. Electric Installation: Connect wiring to building electrical system.

3.03 OPERATIONAL GYMNASIUM EQUIPMENT

A. Operating Gymnasium Equipment: Verify clearances of movable components of gymnasium equipment throughout entire range of operation and for access to operating components.

3.04 FLOOR INSERTS

A. Floor Inserts:
1. Coordinate locations with application of game lines and markers.
2. Coordinate installed elevation heights of floor inserts with installation and field finishing of finish flooring; ensure that installed cover plates are flush with adjacent flooring.
3. Installation:
a. Clean oversized, recessed voids in concrete substrate of debris.
b. Position each sleeve, and fill void around sleeve with grout, mixed and placed according to grout manufacturer's written instructions.
c. Hold sleeve in proper position until grout is sufficiently cured.

3.05 WALL SAFETY PADS

A. Install wall padding securely, with edges tight to wall and without wrinkles in fabric covering.

B. Bottom of pads shall be 4 inches above finish floor unless otherwise indicated.
C. Limit cuts in face of wall padding so that cuts are securely and fully concealed behind cutout trim.

3.06 ADJUSTING

A. Verify proper placement of equipment.
B. Verify proper placement of floor inserts; install volleyball standard posts and equipment and verify installation is proper and all equipment functions correctly.
C. Perform operational tests of all operable equipment.
   1. Adjust operating equipment for proper operation; remove and replace equipment causing noise or vibration; lubricate equipment as recommended by manufacturer.
   2. Verify that limit switches are properly set.

3.07 CLEANING

A. Remove masking or protective covering from finished surfaces.
B. Clean equipment in accordance with manufacturer's recommendations.

3.08 PROTECTION

A. Protect installed products until Date of Substantial Completion.
B. Replace damaged products before Date of Substantial Completion.

3.09 DEMONSTRATION

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

END OF SECTION 11 6623

SECTION 12 3216 - MANUFACTURED PLASTIC LAMINATE-CLAD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured plastic laminate casework.
B. Countertops.- In Section 12 3600 Countertops

1.02 DEFINITIONS

A. Exposed: Portions of casework visible when drawers and cabinet doors are closed, including end panels, bottoms of cases more than 42 inches above finished floor, tops of cases less than 72 inches above finished floor and all members visible in open cases or behind glass doors.
B. Semi-Exposed: Portions of casework and surfaces behind solid doors, tops of cases more than 72 inches above finished floor and bottoms of cabinets more than 30 inches but less than 42 inches above finished floor.
C. Concealed: Sleepers, web frames, dust panels and other surfaces not generally visible after installation, and bottoms of cabinets less than 30 inches above finished floor.

1.03 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
B. ANSI A208.1 - American National Standard for Particleboard; 2022.
C. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
D. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
E. ASTM C1036 - Standard Specification for Flat Glass; 2021.
F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
G. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
H. BHMA A156.18 - Standard for Materials and Finishes; 2020.
I. BHMA A156.9 - Cabinet Hardware; 2020.
J. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2024.
K. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
L. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 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. Keying Conference: Conduct conference prior to ordering keys. Incorporate conference decisions into keying submittal.
C. Coordinate the work with placement of concealed framing, blocking, and reinforcements that support casework.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: For each product. Include component dimensions, configurations, construction details, joint details, attachments.
C. Shop Drawings: Indicate casework types, sizes, and locations, using large scale plans, elevations, and cross sections. Include filler panels, rough-in and anchors, reinforcements, and blocking, placement dimensions and tolerances, clearances required, and keying information.
    1. Indicate manufacturer's catalog number for each unit of casework.
    2. Indicate plumbing locations and electrical service locations.
D. Samples:

1. Plastic Laminate: Submit 3 samples 3 by 6 inches in size showing each color, texture, and finish selected.
2. Edge Banding: Submit 3 samples 6 inches in length showing each color and finish selected.
3. Solid Surfacing:Submit 3 samples 4 by 4 inches in size, for each type, color, pattern, and finish.

E. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.

F. Casework Samples: Representative of types in the project.
1. To be provided only upon request of Architect.
   a. Base Cabinet: Cabinet with drawer and door and specified hardware.
   b. Wall Cabinet: Cabinet with shelves and supports, door and specified hardware.

G. Manufacturer's Qualification Statement.

H. Installer's Qualification Statement.

I. Maintenance Data: Manufacturer's recommendations for care and cleaning.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Door Hinges: For each type, quantity equal to 2 percent of total installed, but not less than 5; includes fasteners.
3. Door Catches: Quantity equal to 2 percent of total installed, but not less than 5, includes fasteners.
4. Door Pulls: For each type, quantity equal to 2 percent of total installed, but not less than 5; includes fasteners.
5. Shelf Supports: Quantity equal to 2 percent of total installed, but not less than 10.
6. Drawer Slides: For each size and type, quantity equal to 2 percent of total installed, but not less than 2 paris; includes fasteners.
7. Locks: For each type, quantity equal to 2 percent of total installed, but not less than 2; includes fasteners.
8. Grommets: Quantity equal to 2 percent of total installed, but not less than 5.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.
1. Licensed under Architectural Woodwork Institute (AWI) Quality Certification Program (QCP).

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than 5 years of documented experience and approved by manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect items provided by this section, including finished surfaces and hardware items during handling and installation.

B. Environmental Requirements: Do not deliver casework until the following conditions have been met:
1. Building has been enclosed (windows and doors sealed and weather-tight).
2. An operational HVAC system that maintains temperature and humidity at occupancy levels has been put in place and will remain operating.
3. Painting and other “wet work” construction is complete in the casework areas.

C. Products delivered to sites that are not enclosed and/or improperly conditioned will not be accepted if warping or damage due to unsatisfactory conditions occurs.

D. Storage:
1. Store casework in the area of installation. If necessary, prior to installation, temporarily store in another area, meeting the above environmental requirements.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion. Defects include, but are not limited to:

1. Delamination of components.
2. Failure of adhesives.
3. Failure of hardware.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Catalog numbers indicated on Drawings are for products manufactured by TMI Systems Design Corporation: www.tmisystems.com.

1. Provide either the indicated "Basis of Design" products or equivalent products from one of the following:
   a. Advanced Cabinet Systems: www.advancedcabinetsystems.com.
   b. Case Systems: www.casesystems.com.
   c. Stevens Industries, Inc.: www.stevensind.com.
   d. Substitutions: See Section 01 6000 - Product Requirements.

B. Obtain casework from single source and manufacturer, unless otherwise indicated.

2.02 PERFROMANCE REQUIREMENTS

A. Accessibility: Comply with ICC A117.1 and ADA Standards.

2.03 MATERIALS

A. Casework Adhesives: As recommended by casework manufacturer.

B. Laminate Adhesive: Type recommended by casework manufacturer to suit application.

C. Wood-based Materials - General:

1. Maximum Moisture Content: 7 percent.

D. Hardwood Plywood: HPVA HP-1, particleboard core.

E. Particleboard: ANSI A208.1, Grade M-2.

1. Moisture resistant where indicated.

F. Medium Density Fiberboard (MDF): ANSI A208.2, Grade 130.

1. Moisture resistant where indicated.

G. Laminates:

1. High-Pressure Decorative Laminate (HPDL); NEMA LD 3; Grades as indicated.
2. Thermally Fused Laminate (TFL) : Melamine resin; NEMA LD 3, Grade VGL.

H. Edgebanding: Rigid PVC extrusions, flat shaped, smooth texture, through color with satin finish. Width to match component thickness.

1. 0.118 inch (3 mm) thick at doors, drawer fronts, and countertops.
2. 0.039 inch (1 mm) thick elsewhere, including exposed exterior cabinet members, top edges of drawer boxes, adjustable shelves, and interior panels.

I. Tempered Glass: Annealed float glass ASTM C1036, Type 1 (Transparent Flat), Class 1 (Clear), Quality Q3; fully tempered per ASTM C1048, Kind FT. Complying with ANSI Z97.1.

1. Glass Thickness: 1/4 inch, minimum.
2. Exposed Edges: Ground smooth.

2.04 HARDWARE AND ACCESSORIES

A. Hardware and Accessories, General:

1. Cabinet Hardware: Comply with BHMA A156.9, types as indicated for quality grade specified.
   a. Finishes:
      1) Exposed Hardware: Provide finish that complies with BHMA A156.18 for BHMA finish number indicated. Unless otherwise indicated, provide the following finishes:

(a) Satin Stainless Steel: BHMA 630.
(b) Satin Chromium Plated: BHMA 626.
2) Concealed Hardware: Provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2. Provide all fasteners, hardware and accessories for a complete installation including:
   a. Undercounter plastic laminate support panels or metal support brackets.
   b. Free-standing table hardware.

B. Hinges: Semiconcealed type, 5 knuckle, institutional grade, hospital tip, 2-3/4 inch overlay, 270 degree opening, 3 way adjustment, 0.095 inch gage, steel with satin finish, Grade 1.
   1. Provide two (2) hinges for doors less than 36 inches high.
   2. Provide three (3) hinges for doors 37 inches to 54 inches high.
   3. Provide four (4) hinges for tall cabinet doors 55 inches to 84 inches high.

C. Door Catches: Heavy-duty magnetic or roller type catch and strike plate.
   1. Doors up to 48 inches high shall have single catch mounted at bottom door edge.
   2. Doors over 48 inches high shall have catch at both the top and bottom edges of door.

D. Pulls:
   1. Type: Back-mounted wire pulls, standard U-shape style.
      a. Material: Solid aluminum, stainless steel, or chrome-plated brass.
      b. Overall Size: 4-1/2 inches wide by 1 inch deep.
   2. Provide as follows:
      a. Doors: Single pull.
      b. Drawers up to 24 inches Wide: Single pull.
      c. Drawers over 24 inches Wide: Two pulls.

E. Drawer Slides: Epoxy coated with nylon rollers or zinc plated with steel ball-bearings; self-closing with positive stop both directions. Load rating at full extension as follows:
   1. Drawers less than 2 inches deep: 50 lbs.
   2. All Drawers 2 to 4 inches deep: 100 lbs.
   3. File Drawer and Drawers over 4 inches deep: 150 lbs.

F. Adjustable Shelf Supports: Double-pin clear polycarbonate shelf rests with shelf anti-tipping feature complying with BHMA A156.9, Type B04013. Designed to mount into pre-drilled holes in casework sides. Each shelf rest shall support 200 lbs, minimum.

G. Locks: Removable core, disc tumbler, cam style lock with strike for drawers and doors. At other locations, use lock style to suit application.
   1. Door Locks: BHMA A156.11, E07121.
   2. Drawer Locks: BHMA A156.11, E07041.
   3. Provide locks on every doors and drawers per room.
      a. All locks within a room shall be keyed alike and different than adjacent rooms. All locks on the Project shall be master keyed.
         1) Provide 2 keys for each room and three 3 master keys.

H. Sliding Door Track: Manufacturer's standard anodized aluminum double channel assembly with track/door rollers; type and size to suit sliding-doors.

I. Grommets: 2 inch outside diameter, molded-plastic grommets and matching plastic caps with wire passage slot.
   1. Color: Black.

J. Coat Rods:
   1. Rod: Minimum 1 inch diameter steel tube; minimum wall thickness 0.075 inch (14 gage).
   2. Brackets: Steel mounting brackets.

K. Casters: Non-marking, soft, rubber wheels with ball bearing assembly.
   1. Brakes: Provide 2 brakes, minimum, per mobile unit.
   2. Load Capacity: 200 pounds, minimum, per caster.

2.05 MANUFACTURED PLASTIC LAMINATE CASEWORK

A. Cabinet Construction - General:
   1. Assembly: Shop assemble casework items for delivery to site in units easily handled and to permit passage through building openings.
      a. Laminate-clad panel construction; each unit self-contained and not dependent on adjacent units or building structure for rigidity; in sizes necessary to avoid field cutting except for scribes and filler panels.
      b. Provide cabinet sizes and configurations as indicated on Drawings.
   2. Quality Standard: AWI/AWMAC/WI (AWS), unless noted otherwise.
      a. Grade: Premium.
   3. Design Style: Flush overlay, frameless construction.

B. Core Material: Particleboard or MDF, unless otherwise indicated.

C. Component Thicknesses: Not less than the following.
   1. General component thicknesses unless otherwise indicated:
      a. Base Cabinets: 3/4 inch.
      b. Wall Cabinets: 3/4 inch.
      c. Tall Cabinets: 3/4 inch.
   2. Cabinet Backs:
      a. 1/4 inch thick.
   3. Shelves:
      a. 36 inches or less in length: 3/4 inch thick, unless otherwise indicated.
      b. Over 36 inches in length: 1 inch thick.
   4. Doors:
      a. Height 48 inches or less: 3/4 inch thick.
      b. Height over 48 inches: 1 inch thick
   5. Drawer Subfronts, Sides and Backs: 1/2 inch thick.
   6. Drawer Bottoms:
      a. 24 inches or less in width: 1/4 inch thick.
      b. Over 24 inches in width: 1/2 inch thick.

D. Exposed Materials:
   1. Laminates: High-Pressure Decorative Laminate (HPDL), Grade VGS.
   2. Edgebanding: Provide specified edgebanding unless noted otherwise.

E. Semi-Exposed Materials:
   1. Laminates: Thermally Fused Laminate (TFL).
   2. Edgebanding: Provide specified edgebanding unless noted otherwise.

F. Concealed Materials:
   1. Laminates: High-Pressure Decorative Laminate (HPDL), Grade BKM, BKV, BKL, or CLS as appropriate for conditions.

G. Joints doweled, glued and screwed.

H. Drawer Materials and Construction: Particleboard with Thermofused Melamine (TFM). Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
   1. Drawer Construction Method: Glued and doweled; with captured bottoms. Drawer bottom minimum 0.25 inches.

I. All cabinets shall be manufactured with balance construction; apply laminate backing sheet to reverse side of plastic laminate finished surfaces.

J. Laminates: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline.

K. Edgebanding: Do not use more than one piece for any single length.

L. Glazing for Doors: Clear tempered glass.

M. Aprons and Modesty Panels: Provide panels matching construction and finish of casework.

N. Scribes and Fillers: Panels of matching construction and finish, for locations where cabinets do not fit tight to adjacent construction.
O. Hardware Application: Factory-machine casework members for hardware that is not surface applied.
P. Provide cutouts for electrical receptacles and other utility, mechanical, and electrical components as indicated.
Q. Access Panels: Provide as required for maintenance of utility service and mechanical and electrical components.

2.06 COUNTERTOPS

A. Countertops: As specified in Section 12 3600.

2.07 ACCESSORIES

A. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
B. Countertop Adhesives: As recommended by solid surfacing manufacturer.

2.08 COLORS AND FINISHES

A. Laminate Colors, Patterns, and Finishes:
   1. High-Pressure Decorative Laminates:
      a. PL1To match Formica Corporation; Storm, 912-ML (Monolith Finish) : www.formica.com.
   2. Thermally Fused Laminates:
      a. Color: White.
B. PVC Edgebanding Colors:
   1. Color(s): Matching adjacent laminate.

PART 3 EXECUTION

3.01 PREPARATION

A. Large Components: Ensure that large components can be moved into final position without damage to other construction.

3.02 EXAMINATION

A. For Base Cabinets Installation: Examine floor levelness and flatness of installation space. Do not proceed with installation if encountered floor conditions required more than 1/2 inch leveling adjustment.
B. For Wall Cabinets Installation: Examine wall surfaces in installation space. Do not proceed with installation if the following conditions are encountered:
   1. Maximum variation from plane of masonry wall exceeds 1/4 inch in 10 ft and 1/2 inch in 20 ft or more, and/or maximum variation from plumb exceeds 1/4 inch per story.
   2. Maximum Variation of finished gypsum board surface from true flatness: 1/8 inch in 10 feet in any direction.
C. Verify adequacy of support framing and anchors.
D. Verify that service connections are correctly located and of proper characteristics.

3.03 CASEWORK INSTALLATION

A. Perform installation in accordance with manufacturer's instructions.
B. Use anchoring devices to suit conditions and substrate materials encountered. Use concealed fasteners to the greatest degree possible. Use exposed fasteners only where allowed by approved shop drawings, or where concealed fasteners are impracticable.
C. Set casework items plumb and square, securely anchored to building structure.
D. Align cabinets to adjoining components, install filler and/or scribe panels where necessary to close gaps.

E. Fasten together cabinets in continuous runs, with joints flush, uniform and tight. Misalignment of adjacent units not to exceed 1/16 inch. In addition, do not exceed the following tolerances:
   1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
   2. Variation of Bottoms of Wall Cabinets from Level: 1/8 inch in 10 feet.
   3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet.
   4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
   5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.

F. Secure wall and floor cabinets to concealed reinforcement at gypsum board assemblies.

G. Base Cabinets: Fasten cabinets to service space framing and/or wall substrates, with fasteners spaced not more than 16 inches on center. Bolt adjacent cabinets together with joints flush, tight, and uniform.
   1. Where base cabinets are installed away from walls or service space framing, anchor to floor at toe space at not more than 24 inches on center, and at sides of cabinets with not less than two fasteners per side.

H. Wall Cabinets: Fasten to hanging strips, and/or wall substrates. Fasten each cabinet through back, near top, at not less than 16 inches on center.

I. Install hardware uniformly and precisely.

J. Replace units that are damaged, including those that have damaged finishes.

3.04 COUNTERTOP INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install countertops in one true plane, with ends abutting at hairline joints, and no raised edges.
   1. Variation From Level/Horizontal: 1/8 inch in 10 feet, maximum.
   2. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
   3. Field Joints: 1/16 inch wide, maximum.
   4. Do not exceed 1/64 inch difference between planes of adjacent units.

C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

D. Attach solid surfacing countertops to subtops using compatible adhesive.
   1. Secure back/end splashes to countertop and vertical substrates with waterproof adhesive.

3.05 ADJUSTING

A. Adjust operating parts, including doors, drawers, hardware, and fixtures to function smoothly.

3.06 CLEANING

A. Clean casework and other installed surfaces thoroughly.

3.07 PROTECTION

A. Do not permit finished casework to be exposed to continued construction activity.

B. Protect casework and countertops from ongoing construction activities. Prevent workmen from standing on, or storing tools and materials on casework or countertops.

C. Repair damage, including to finishes, that occurs prior to Date of Substantial Completion, using methods prescribed by manufacturer; replace units that cannot be repaired to like-new condition.

END OF SECTION 12 3216

SECTION 12 3600 - COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Countertops for architectural cabinet work.
B. Countertops for manufactured casework.

1.02 REFERENCE STANDARDS

A. ANSI A208.1 - American National Standard for Particleboard; 2022.
B. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
D. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2019.
E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
F. AWI (QCP) - Quality Certification Program; Current Edition.
G. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
H. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
I. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
J. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
K. NSF 51 - Food Equipment Materials; 2023.
L. PS 1 - Structural Plywood; 2023.
M. SEFA 2 - Installations; 2010.
N. SEFA 3 - Laboratory Work Surfaces; 2020.
O. WI (CCP) - Certified Compliance Program (CCP); Current Edition.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Specimen warranty.
C. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.
D. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.
E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.
F. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
G. Installation Instructions: Manufacturer's installation instructions and recommendations.
H. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.
B. Quality Certification:
   1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.

2. Comply with WI (CCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.woodworkinstitute.com/#sle.
3. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
4. Provide designated labels on shop drawings as required by certification program.
5. Provide designated labels on installed products as required by certification program.
6. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.
B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 FIELD CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOPS

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
B. Quality Standard: SEFA 3 for laboratory worksurfaces.
C. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
    1. Flat Sheet Thickness: 1/2 inch, minimum.
    2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
        a. Manufacturers:
            1) Dupont; Silver Birch: www.corian.com/#sle.
        b. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
        c. Color and Pattern: SS1 - Dupont Corian, Silver Birch.
    3. Other Components Thickness: 1/2 inch, minimum.
    4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; square edge.
    5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.

2.02 MATERIALS

A. Extruded Aluminum: ASTM B211/B211M, 6463 alloy, T5 temper.
B. Wood-Based Components:
    1. Wood fabricated from old growth timber is not permitted.
C. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
D. Particleboard for Supporting Substrate: ANSI A208.1 Grade 2-M-2, 45 pcf minimum density; minimum 3/4 inch thick; join lengths using metal splines.
E. Medium Density Fiberboard for Supporting Substrate: ANSI A208.2.
F. Provide moisture resistant substrates at sink base, countertop, and splash within 18" of sink.
G. Provide marine grade substrates at high humid and/or moist environments.
H. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
I. Joint Sealant: Mildew-resistant silicone sealant, white.

J. Polyester Laminate Protective Film: Scratch-, heat-, and acid-resistant optically clear removable polyester film for bonding to stone counters.
   1. Thickness: 4 mil, 0.004 inch, minimum.
   2. Finish: Satin.
   3. Adhesive Type: Pressure sensitive acrylic.
   4. NSF approved for food contact per NSF 51.

K. Sealer: Stain and acid protection for natural stone counters.
   1. NSF approved for food contact per NSF 51.
   2. Products:
      a. Custom Building Products; _____: www.custombuildingproducts.com/#sle.
      b. Rockstar Sealing, a division of TuffSkin Surface Protection LLC; Natural Finish Stone Sealer: www.rockstarsealing.com/#sle.
      c. STONETECH, a division of LATICRETE International, Inc; _____: www.laticrete.com/#sle.
      d. Substitutions: See Section 01 6000 - Product Requirements.

2.03 ACCESSORIES

A. Fixed Top-Mounted Countertop Support Brackets:
   1. Tee-Shaped Brackets: 2 inch by 3 inch by 3/16 inch Tee.
   2. Material: 6063-T6 extruded Aluminum.
   3. Finish: Manufacturer's standard, factory-applied, textured powder coat.
   4. Color: Clear Anodized.
   5. Size: 18 inch support unless otherwise indicated.
   6. Products - Concealed flush mount:
      a. Rakks Model EH1818-FM; Rangine Corp.: www.rakks.com.
      b. Or equal by A&M Hardware, Inc.; www.aandmhardware.com.
      c. Substitutions: See Section 01 6000 - Product Requirements.

2.04 FABRICATION

A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
   1. Join lengths of tops using best method recommended by manufacturer.
   2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
   3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.

B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
   1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
   2. Height: 4 inches, unless otherwise indicated.

C. Solid Surfacing: Fabricate tops and wall panels up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

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.

3.03 INSTALLATION

A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
B. Apply sealer products in accordance with manufacturer's written instructions.
C. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

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

END OF SECTION 12 3600

SECTION 13 3419 - METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufacturer-engineered, shop-fabricated structural steel building frame.
B. Insulated Metal wall and roof panels including soffits and gutters and downspouts
C. Pipe Type Snow Guards

1.02 RELATED REQUIREMENTS

A. Section 07 9200 - Joint Sealants: Sealing joints between accessory components and wall system.
B. Section 08 1113 - Hollow Metal Frames.
C. Sectiuon 08 1610 - FRP Faced Aluminum Doors
D. Section 08 3613 - Sectional Doors.
E. Section 08 4313 - Aluminum Framed Storefronts
F. Section 08 4500 - Translucent Wall Assemblies
G. Section 08 8000 - Glazing.

1.03 REFERENCE STANDARDS

A. AISC 360 - Specification for Structural Steel Buildings; 2022, with Errata (2025).
B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
E. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
F. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
G. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
H. ASTM A529/A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality; 2019.
I. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
J. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2023.
K. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
L. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
M. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
N. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2023a.
O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
P. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.

Q. 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.
R. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
S. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021, with Errata (2023).
T. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
U. IAS AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems; 2024.
V. MBMA (MBSM) - Metal Building Systems Manual; 2024.
W. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.
X. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data on profiles, component dimensions, fasteners.
C. Shop Drawings: Indicate assembly dimensions, locations of structural members, connections; wall and roof system dimensions, panel layout, general construction details, anchors and methods of anchorage, and installation; framing anchor bolt settings, sizes, locations from datum, and foundation loads; indicate welded connections with AWS A2.4 welding symbols; indicate net weld lengths; provide professional seal and signature.
D. Samples: Submit two samples of precoated metal panels for each color selected, 12 by 12 inch in size illustrating color and texture of finish.
E. Manufacturer's Instructions: Indicate preparation requirements, anchor bolt placement.
F. Erection Drawings: Indicate members by label, assembly sequence, and temporary erection bracing.
G. Designer's Qualification Statement.
H. Manufacturer's Qualification Statement: Provide documentation showing metal building manufacturer is accredited under IAS AC472.
    1. Include statement that manufacturer designs and fabricates metal building system as integrated components and assemblies, including but not limited to primary structural members, secondary members, joints, roof, and wall cladding components specifically designed to support and transfer loads and properly assembled components form a complete or partial building shell.
I. Erector's Qualification Statement.
J. Welders’ Qualification Statement: Welders’ certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
K. Project Record Documents: Record actual locations of concealed components and utilities.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design structural components, develop shop drawings, and perform shop and site work under direct supervision of a Professional Structural Engineer experienced in design of this type of work.
    1. Design Engineer Qualifications: Licensed in the State in which the Project is located.
    2. Comply with applicable code for submission of design calculations as required for acquiring permits.

3. Cooperate with regulatory agency or authorities having jurisdiction (AHJ), and provide data as requested.

B. Perform work in accordance with AISC 360 and MBMA (MBSM).
1. Maintain one copy on site.

C. Manufacturer Qualifications: Company specializing in the manufacture of products similar to those required for this project.
1. Not less than Five years of documented experience.

D. Erector Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

E. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and no more than 12 months before start of scheduled welding work.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide five year manufacturer warranty for Paint Finish.
1. Include coverage for exterior pre-finished surfaces to cover pre-finished color coat against chipping, cracking or crazing, blistering, peeling, chalking, or fading. Include coverage for weather tightness of building enclosure elements after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Buildings Systems:
1. Varco Pruden; varcopruden.com
2. Butler Manufacturing Company; ____: www.butlermfg.com/#sle.
3. Ceco Building Systems; ____: www.cecobuildings.com/#sle.
4. Nucor Building Systems; _____: www.nucorbuildingsystems.com/#sle.
5. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ASSEMBLIES

A. Single span rigid frame.

B. Bay Spacing: As indicated on Drawings

C. Primary Framing: Rigid frame of rafter beams and columns, canopy beams and braced end frames, and wind bracing.

D. Secondary Framing: Purlins, Girts, Eave struts, Flange bracing, Sill supports, and Clips, and other items detailed.

E. Wall System: Preformed metal panels of vertical profile, with sub-girt framing/anchorage assembly, and accessory components.

F. Roof System: Preformed metal panels oriented parallel to slope, with sub-girt framing/anchorage assembly, insulation, and liner panels, and accessory components.

G. Roof Slope: As indicated on Drawings.

H. Pipe Type Snow Guard: Continuous snow guard; manufacturer's standard dual pipe set in brackets with snow plates to resatrict migration of snow beneath pipes.
1. Brackets: Stainless Steel.
2. Pipe or Square Tube: Aluminum Mill Finish.
a. Outside Diameter, Round: 1 inch nominal.
b. Outside Dimensions, Square: 1 inch by 1 inch.
3. Supplimental Plates and Clips: Attached to horizontal component; match finish of pipe.
4. Clamps for Standing Seam Roof: Stainless Steel clamps attached to standing seams of roof panels; for attachement of pipe type snow guards:
a. Seam Profile: Selected by Atchityect from Manufacturer's full range: Match profile of metal roof.
b. Secure clamps to metal roof with stainless steel set screws incorporating round non-penetrating point.

5. Finish: Mill Finish.
6. Products:
   a. Ace Clamp, PMC Industries, Inc.; A2 2 bar Snow Guard System: www.aceclamp.com.
   b. Alpine Snow Guards; ASG4025 Two Pipe Snow Guard: www.alpinesnowguards.
   c. Metal Roof Inovations, Ltd.,l S-51 Attachment Solutions: www.s5.com
   d. Substitutions: See Section 01 6000 -= Product Requirements.

2.03 PERFORMANCE REQUIREMENTS

A. Installed Thermal Resistance of Wall System: R-value of 10 c.i..
B. Installed Thermal Resistance of Roof System: R-value of 30.
C. Design structural members to withstand dead load, applicable snow load, and design loads due to pressure and suction of wind calculated in accordance with design loads. Refer to structural drawings for loading requirements..
D. Provide drainage to exterior for water entering or condensation occurring within wall or roof system.
E. Permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to temperature range of ____ degrees F.
F. Size and fabricate wall and roof systems free of distortion or defects detrimental to appearance or performance.

2.04 MATERIALS - FRAMING

A. Structural Steel Members: ASTM A36/A36M.
B. Structural Tubing: ASTM A500/A500M Grade B cold-formed.
C. Plate or Bar Stock: ASTM A529/A529M, Grade 50.
D. Anchor Bolts: ASTM A307, Grade A, with no preference for protective coatings.
E. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1; galvanized to ASTM A153/A153M.
F. Welding Materials: Perform in accordance with AWS D1.1/D1.1M.
G. Primer: SSPC-Paint 20 zinc rich.
H. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
   1. Minimum Compressive Strength at 48 Hours: 2,000 pounds per square inch.
   2. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch.

2.05 MATERIALS - WALLS AND ROOF

A. Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, Designation SS (structural steel), Grade 33 (230), with G90/Z275 coating.
B. Metal Building Type, Wall: Factory Applied, Vapor-Barrier Insulation Facings: Water vapor permeance no greater than 0.10 perm when tested in accordance with ASTM E96/E96M; flame spread index of 25 or less, and smoke developed index of 40 or less when tested in accordance with ASTM E84.
C. Metal Building Type, Roof: Rigid Cellular Polyisocyanurate (ISO) Thermal Insulation Board with Facers Both Sides: Complying with ASTM C1289.
   1. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
   2. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
D. Fasteners: Manufacturer's standard type, galvanized to comply with requirements of ASTM A153/A153M, finish to match adjacent surfaces when exterior exposed.
E. Bituminous Paint: Asphaltic type.
F. Sealant: ASTM C920, elastomeric sealant with movement capability of at least plus/minus 50 percent; 100 percent silicone; for exposed applications, match adjacent colors as closely as possible.

G. Trim, Closure Pieces, Caps, Flashings, Gutters, Downspouts, Rain Water Diverter, Fascias, and Infills: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

2.06 COMPONENTS - (BY OTHERS)

A. Doors and Frames:
   1. See Section 08 1113 - Hollow Mwtal Doors and Frames
   2. See Section 08 1610 - FRP Faced Aluminum Doors
B. Overhead Doors: See Section 08 3613.
C. Windows: Aluminum Framed Storefronts; See Section No 08 4313.
   1. Glass and Glazing: See Section 08 8000.
D. Wall Louvers: See Section 08 9100.

2.07 FABRICATION - FRAMING

A. Fabricate members in accordance with AISC 360 for plate, bar, tube, or rolled structural shapes.
B. Anchor Bolts: Formed with bent shank, assembled with template for casting into concrete.
C. Provide wall opening framing for doors, windows, and other accessory components.

2.08 FABRICATION - WALL AND ROOF PANELS

A. Siding: Minimum 0.023 inch metal thickness, ____ profile indicated, ____ inch deep, lapped edges fitted with continuous gaskets.
B. Roofing: Minimum ____ inch metal thickness, ____ profile, lapped edges fitted with continuous gaskets.

END OF SECTION 13 3419

SECTION 14 2123.16 - MACHINE ROOM-LESS ELECTRIC TRACTION PASSENGER ELEVATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Complete machine room-less electric traction elevator systems.
   1. Passenger type.

1.02 ABBREVIATIONS AND ACRONYMS

A. MRL: Machine room-less.

1.03 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
B. AISC 360 - Specification for Structural Steel Buildings; 2022, with Errata (2025).
C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
D. ASME A17.1 - Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices; 2022.
E. ASME A17.2 - Guide for Inspection of Elevators, Escalators, and Moving Walks Includes Inspection Procedures for Electric Traction and Winding Drum Elevators, Hydraulic Elevators, Inclined Elevators, Limited-Use/Limited-Application Elevators, Private Residence Elevators, Escalators, Moving Walks, Dumbwaiters, and Material Lifts; 2023.
F. ASME QEI-1 - Standard for the Qualification of Elevator Inspectors; 2018.
G. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2023a.
H. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
I. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2024.
J. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
K. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
L. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.
M. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
N. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
O. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
P. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
Q. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
R. NEMA MG 00001 - Motors and Generators; 2024.
S. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
T. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
U. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate this work with installation of hoistway wall construction.

2. Coordinate work of this section with installers providing associated equipment, accessories, hardware, and related items and systems not included in this section but required for a complete and proper elevator installation. Work not included in this section, includes, but is not limited to, the following:
   a. Concrete and masonry items; refer to Divisions 03 and 04 :
      1) Concrete and masonry inserts, sleeves, and anchors.
   b. Steel items; refer to Division 05:
      1) Hoist beams.
      2) Pit ladders.
      3) Auxiliary steel supports for guide rail brackets.
      4) Steel angle supports for sills.
   c. Floor finishes; refer to Division 09:
      1) Floor finishes.
   d. Fire suppression items; refer to Division 21:
      1) Hoistway fire protection sprinkler system.
   e. Mechanical items; refer to Divisions 22 and 23:
      1) Elevator pit sump pump.
      2) Hoistway venting or pressurization system.
   f. Electrical items; refer to Divisions 26 and 27:
      1) Electrical service to elevators.
      2) Telephone service to machine room.
      3) Conduits for wiring between automatic transfer switch and controller cabinet.
      4) Conduits for wiring between fire alarm panel and controller cabinet.
      5) Smoke detectors and heat detectors; including contacts wired to controller cabinet.
      6) Automatic transfer switches with auxiliary contacts for emergency power transfer status indication.
      7) Shunt trip devices for automatic disconnection of elevator power prior to fire suppression system activation; including shunt trip power monitoring.
      8) Elevator pit lighting and duplex outlet.
      9) Machine space lighting and duplex outlet.
   g. Miscellaneous items:
      1) Governor access door.

B. Preinstallation Meeting: Convene meeting at least one week prior to start of this work.
   1. Review schedule of installation, proper procedures and conditions, and coordination with related work.

C. Construction Use of Elevator: Not permitted.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit data on following items:
   1. Signal and operating fixtures, operating panels, and indicators.
   2. Car design, dimensions, layout, and components.
   3. Car and hoistway door and frame details.
   4. Electrical characteristics and connection requirements.

C. Shop Drawings: Provide appropriate plans, elevations, sections, diagrams, and details including, but not limited to, the following:
   1. Car, shaft and elevator pit dimensions.
   2. Elevator Equipment and Machines: Size and location of driving machines, power units, controllers, governors, and other components.
   3. Hoistway Components: Size and location of car machine beams, guide rails, buffers, ropes, and other components.
   4. Rail bracket spacing; maximum loads imposed on guide rails requiring load transfer to building structural framing.

5. Individual weight of principal components; load reaction at points of support.
6. Loads on hoisting beams.
7. Clearances and over-travel of car and counterweight.
8. Locations in hoistway and machine room of traveling cables and connections for car lighting, telephone, and any other equipment indicated or required.
9. Location and sizes of hoistway and car doors and frames.
10. Electrical characteristics and connection requirements.
11. Indicate arrangement of elevator equipment and allow for clear passage of equipment through access openings.

D. Samples:
1. Finishes: Submit 3 samples 3 by 6 inches in size for each material, finish and color selected; including, but not limited to, the following:
a. Car interior finishes.
b. Car and hoistway door and frame finishes.
c. Handrail material and finish.
d. Signaling equipment finishes.

E. Selection Samples: Where colors and finishes are not specified, submit 3 sets of color and finish selection charts or chips.

F. Manufacturer's Qualification Statement.

G. Installer's Qualification Statement.

H. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

I. Initial Maintenance Contract.

J. Maintenance Contract: Submit proposal to Owner for standard two year continuing maintenance contract agreement in accordance with ASME A17.1 and requirements as indicated, starting on date initial maintenance contract is scheduled to expire.
1. Indicate in proposal the services, obligations, conditions, and terms for agreement period and for renewal options.

K. Operation and Maintenance Data:
1. Parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
2. Operation and maintenance manual.
3. Schematic drawings of equipment, and wiring diagrams of installed electrical equipment with list of corresponding symbols to identify markings on machine room and hoistway apparatus.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design guide rails under direct supervision of a licensed Professional Structural Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience and approved by elevator manufacturer.

D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) or testing agency acceptable to authorities having jurisdiction as suitable for the purpose indicated in construction documents.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide manufacturer's warranty for elevator operating equipment and devices for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design - MRL Electric Traction Elevators: KONE Inc.; MonoSpace 500: www.kone.us.
B. Other Acceptable Products - MRL Electric Traction Elevators:
   1. Otis Elevator Company; ____: www.otis.com.
   2. Schindler Elevator Corporation; Schindler 3300XL: www.us.schindler.com.
   3. ThyssenKrupp Elevator ; Evolution 100:: www.thyssenkruppelevator.com.
   4. Substitutions: See Section 01 6000 - Product Requirements.
C. Products other than Basis of Design are subject to compliance with specified requirements and shaft and pit dimensions indicated on Drawings. By using products other than Basis of Design, the Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees, changes to elevator pit dimensions, changes to elevator shaft dimensions including openings, and changes to floor plans as a result of changes to the elevator shaft dimensions.
D. Source Limitations: Provide elevator and associated equipment and components produced by a single manufacturer and obtained from a single supplier.

2.02 PERFORMANCE REQUIREMENTS

A. Elevator Car Floor Deflection:
   1. Limit car floor deflection to L/960.
B. Regulatory Requirements: Comply with ASME A17.1, applicable local codes, and authorities having jurisdiction (AHJ).
C. Accessibility Requirements: Comply with ADA Standards and ICC A117.1.
D. Perform structural steel design, fabrication, and installation in accordance with AISC 360.
E. Comply with seismic design requirements in accordance with ASME A17.1, applicable local codes, and authorities having jurisdiction (AHJ).
   1. Comply with Elevator Safety Requirements for Seismic Risk Zone in accordance with ASME A17.1, ASCE 7 and other related requirements.
      a. Project Seismic Risk: As indicated on drawings.
F. Perform welding of steel in accordance with AWS D1.1/D1.1M.
G. Fabricate and install door and frame assemblies in accordance with NFPA 80 and complying with requirements of authorities having jurisdiction (AHJ).
H. Perform electrical work in accordance with NFPA 70.

2.03 MATERIALS

A. Rolled Steel Sections, Shapes, Rods: ASTM A36/A36M.
B. Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel), with matte finish.
C. Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.
D. Stainless Steel Sheet: ASTM A666/A666M, Type 304; No. 4 Brushed finish unless otherwise indicated.
E. Stainless Steel Bars, Shapes and Moldings: ASTM A276/A276M, Type 304.
F. Textured Stainless Steel Sheet: ASTM A240/A240M, Type 304 with embossed texture rolled into exposed surface.
   1. Products:
      a. Rigidized Metals Corp.; 5WL pattern: www.rigidized.com.
      b. Substitutions: See Section 01 6000 - Product Requirements.
G. Aluminum Sheet: ASTM B209 (ASTM B209M), 3105 alloy, O temper.
H. Nickel Silver Extrusions: ASTM B151, Alloy UNS No. C74500 or UNS No. C77600
I. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.04 MRL ELECTRIC TRACTION ELEVATORS

A. Electric Traction Passenger Elevator:
   1. Drawing Designation(s): ELEV 1.
   2. Electric Traction Elevator Equipment:
      a. Permanent magnet gearless traction machine.
   3. Drive System:
      a. Synchronous alternating current (AC) motors and variable voltage variable frequency (VVVF) drive.
   4. Operation Control Type:
      a. Selective Collective Automatic Operation Control.
   5. Service Control Type:
      a. Standard service control.
      b. Independent service control.
   6. Electrical Power: 480 volts; alternating current (AC); three phase; 60 Hz.
   7. Freight Car Loading Classification: Class A - General Freight Loading in compliance with ASME A17.1.
   8. Rated Net Capacity: 3500 pounds.
   9. Rated Speed: 200 feet per minute.
   10. Interior Car Height: 93 inches (7 feet, 9 inches).
   11. Interior Car Platform Size:
      a. Width: 77-1/2 inches (6 feet, 5-1/2 inches).
      b. Depth: 66-1/2 inches (5 feet, 6-1/2 inches).
   12. Car and Hoistway Entrance Sizes:
      a. Width: 48 inch.
      b. Depth: 84 inch.
   13. Hoistway Size:
      a. Width: 102 inches (8 feet, 6 inches).
      b. Depth: 77 inches (6 feet, 11 inches).
   14. Elevator Pit Depth: 60 inches (5 feet). - Coordinate with manufacturer.
   15. Overhead Clearance at Top Floor: 156 inches (13 feet) - Coordinate with manufacturer.
   16. Travel Distance: As indicated on drawings.
   17. Number of Stops: 3.
   18. Number of Openings: 3 as follows:
      a. Front: 3.
   19. Traction Machine Location: Top of hoistway shaft against wall.
   20. Auxiliary Features:
      a. Automatic dispatching of loaded car.
      b. Nuisance-call cancel.
      c. Automatic leveling.
      d. Automatic operation of lights and fan.
   21. Emergency Power: Battery back-up.

2.05 CAR AND HOISTWAY ENTRANCES

A. Hall Signals and Controls: Stainless steel.
   1. Finish/Pattern: No. 4 Brushed.
B. Car and Hoistway Entrances:
   1. Drawing Designation(s): ELEV 1.
   2. Hoistway Fire Rating: As indicated on drawings.
   3. Elevator Door Fire Rating: As indicated on drawings.
   4. Framed Car Opening Finish and Material: Brushed stainless steel.
   5. Car Door Material: Stainless steel, with rigid sandwich panel construction.
      a. Finish/Pattern: No. 4 Brushed.
   6. Hoistway Frame Material: Stainless steel.
      a. Finish/Pattern: No. 4 Brushed.

7. Hoistway Door Material: Stainless steel, with rigid sandwich panel construction.
   a. Finish/Pattern: No. 4 Brushed.
8. Door Type: Double leaf.
9. Door Operation: Side opening, two speed.
10. Sills: Nickel silver.
    a. Finish: Mill.

C. Sills/Thresholds: Configure to align with frame return and coordinate with floor finish.

D. Gasketing: Provide acoustic type gasketing at hoistway doors and frames to minimize audible noise due to car activities in the hoistway, and air pressure differential between hoistway and landing floors.

2.06 CAR EQUIPMENT AND MATERIALS

A. Elevator Car:
1. Drawing Designation(s): ELEV 1.
2. Car Control Panel:
   a. Material: Stainless steel.
   b. Finish/Pattern: No. 4 Brushed.
3. Car Position Indicator:
   a. Location: Integral with car control panel.
4. Provide convenience outlet receptacle; 110VAC, 15 amps, integral with car control panel or located below it.
5. Ventilation: Two speed fan with grille above ceiling.
6. Flooring: Resilient vinyl tile.
   a. Refer to Section 09 6500 - Resilient Flooring.
7. Wall Base: Recessed stainless steel, 4 inch high.
   a. Finish: No. 4 Brushed.
8. Door Wall/Front Return Panel: Stainless steel.
   a. Finish/Pattern: No. 4 Brushed.
9. Side Walls: Stainless steel.
   a. Finish/Pattern: No. 4 Brushed.
10. Rear Wall: Stainless steel.
    a. Finish/Pattern: No. 4 Brushed
11. Reveals: Stainless steel.
    a. Finish/Pattern: No. 4 Brushed.
12. Hand Rail: Stainless steel, at rear and side walls. Provide open clearance space 1-1/2 inch (38 mm) wide to face of wall.
    a. Flat Bar Stock, Solid: 3/8 inch thick by 4 inch high.
    b. Stainless Steel Finish: No. 4 Brushed.
13. Ceiling:
    a. Concealed Frame Suspended Panel Ceiling: Stainless steel.
    b. Panel Finish: No. 4 Brushed stainless steel.
    c. Lighting: Round LED recessed spotlights.
14. Provide emergency access panel for egress from car at ceiling.
15. Car Top Inspection Station: Provide inspection station on car top for inspection and maintenance. Station to include the following:
    a. GFCI convenience outlet receptacle; 110VAC, 20 amps.
    b. LED/incandescent light with guard; locate light switch on cab top.
    c. Control panel with the following controls:
       1) Constant contact up and down buttons.
       2) Emergency stop button.
       3) Inspection control toggle switch.
    d. Safety railings complying with ASME A17.1.

B. Car Accessories:

1. Certificate Frame: Stainless steel frame glazed with clear tempered glass, and attached with tamper-proof screws.
2. Protective Pads: Canvas cover, padded with impact-resistant fill material, sewn with piping edges; fire resistant in compliance with ASME A17.1; brass grommets for supports, covering side and rear walls and front return, with cut-out for control panel; provide one set for each elevator.
   a. Color: Grey.
   b. Provide at least 4 inch clearance from bottom of pad to finished floor.
   c. Pad Supports: Stainless steel studs, and mounted from top of wall panels.

2.07 COMPONENTS

A. Elevator Equipment:
1. Motors, Controllers, Controls, Buttons, Wiring, Devices, and Indicators: Comply with NFPA 70 requirements, and refer to Section 26 0583 for additional requirements.
2. Guide Rails, Cables, Counterweights, Sheaves, Buffers, Attachment Brackets and Anchors: Design criteria for components includes safety factors in accordance with applicable requirements of Elevator Code, ASME A17.1.
3. Buffers:
   a. Spring type for elevators with speed less than or equal to 200 feet per minute.
4. Lubrication Equipment:
   a. Provide grease fittings for periodic lubrication of bearings.
   b. Grease Cups: Automatic feed type.
   c. Lubrication Points: Visible and easily accessible.

B. Electrical Equipment:
1. Motors: NEMA MG 1.
2. Boxes, Conduit, Wiring, and Devices: Complying with NFPA 70 and in accordance with Division 26.
3. Spare Conductors: Provide ten percent in extra conductors and two pairs of shielded audio cables in traveling cables.
4. Include wiring and connections to elevator devices remote from hoistway and between elevator machine room. Provide additional components and wiring to suit machine room layout. Comply with Division 26.

2.08 OPERATION CONTROLS

A. General:
1. Provide signal and control equipment with buttons that light when activated and remain lit until call has been fulfilled.
2. Provide vandal-resistant buttons and lighted elements illuminated with LEDs.
3. Provide flush mounted recessed units.

B. Hall Signals and Controls:
1. Call Stations:
   a. Provide one button for originating "Up" calls and one button for originating "Down" calls; provide single button at terminating landings.
   b. Emergency Pictorial Signage: Provide text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and other exits should be used.
2. Hall Lanterns:
   a. Provide illuminated "Up" and "Down" arrows; provide single arrow at terminating landings.
   b. Mount above entrance frames.
3. Hall Annunciator: Provide audible signals indicating car arrival and direction of travel.
   a. Signals sound once for "Up" and twice for "Down".
   b. Provide at each hall lantern or mount on car.
4. Car Position Indicators:

a. Provide illuminated, digital car position indicators, located above hoistway entrance at main lobby.
b. Car position indicators may be integrated with hall lanterns mounted above entrance frames.

C. Car Control Panel:
1. Mount in return panel adjacent to car door.
2. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
3. Provide illuminated, digital car position indicator.
4. Provide Illuminated arrows indicating travel direction.
5. Provide audible signals to indicate car is either stopping at or passing a floor.
6. Push Buttons: Provide the following:
a. One button for each floor/stop.
b. Door open and close buttons.
c. Alarm.
7. Keyed Switches:
a. Provide keyed switches for the following:
1) Independent service operation.
2) Lights.
3) Fan.
4) Inspection control.
8. Provide additional emergency buttons and switches as required by code.
9. Emergency Communication System:
a. Hands-free, two-way voice communication system.
b. Include identification, instructions for use, and battery backup power supply.
c. Connect to elevator phone monitoring service as directed by Owner.
10. Each car control panel shall be etched or engraved with State serial number, capacity, and number of passengers as certified by the State Inspector.

D. Door Operation Controls:
1. Program door control to open hoistway and car doors automatically and simultaneously when car arrives at floor landing.
2. Door Safety Devices: Provide infrared curtain unit with auxiliary photo-eyes. Infrared sensor system shall be full height on the leading door edge and opposite jamb.
a. System shall project infrared beams across the car opening detecting the presence of a person or object. If beams are interrupted while doors are closing, doors shall reverse and reopen. After the obstruction is cleared, the doors shall begin to close again.
3. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, buzzer shall sound and doors shall begin to close at reduced kinetic energy.

E. Interconnect elevator control system with fire alarm and smoke alarm systems.

F. Provide "Firefighter's Emergency Operation" in accordance with ASME A17.1, applicable building codes, and authorities having jurisdiction (AHJ).
1. Designated Landing: At ground floor.

2.09 OPERATION CONTROL TYPE

A. Selective Collective Automatic Operation Control: Applies to car in single elevator shaft.
1. Refer to description provided in ASME A17.1.
2. Automatic operation by means of one button in the car for each landing served and by "UP" and "DOWN" buttons at the landings.
3. Stops are registered by momentary actuation of landing car buttons without consideration of the number of buttons actuated or the sequence buttons are actuated, but the stops are made in the order that landings are reached in each direction of travel.
4. All "UP" landing calls are made when car is traveling in the up direction.
5. All "DOWN" landing calls are made when car is traveling in the down direction.

6. Uppermost and lowermost calls are answered as soon as they are reached without consideration of the car travel direction.

2.10 SERVICE CONTROL TYPE

A. Independent Service Control:
   1. Provide key operated "Independent Service" on car operating panel. Key activation will remove that car from normal operation and cancel pre-registered car calls.
   2. Car will respond to selected floor. Car will not respond to any calls from landing call buttons. Car will only respond to calls placed on the car operating panel. Doors will remain open at last landing requested. Doors will close with a constant pressure on "Door Close" button.
   3. Key activation to normal operation will return car to normal operation.

2.11 AUXILIARY FEATURES

A. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
   1. Car shall bypass all hall calls when Automatic Dispatching is activated
   2. Car shall cancel all travel when load limits are exceeded.
B. Nuisance-Call Cancel: When car calls exceed preset number while car load is less than predetermined weight, all car calls are canceled.
   1. Preset number of calls and predetermined weight are adjustable.
C. Automatic Leveling: Automatic leveling shall bring car to a stop within 1/8 inch of the landing level regardless of load or direction of travel.
D. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after five minutes and are re-energized before car doors open.

2.12 EMERGENCY POWER

A. Elevator Emergency Power Supply: Supplied by battery backup; provide elevator system components as required for emergency power characteristics.
B. Emergency Lighting: Comply with ASME A17.1 elevator lighting requirements.
C. Provide operational control circuitry for adapting the change from normal to emergency power.
D. Battery-Powered Automatic Evacuation: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are moved one at a time to the next floor above or below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system

2.13 MACHINE ROOM FITTINGS

A. Key Cabinet: Wall-mounted, lockable, keyed to building keying system, for control and operating panel keys.
   1. Provide three control/operating panel keys.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting this work.
B. Verify that hoistway, pit, and machine room are ready for work of this section.
C. Verify hoistway shaft and openings are of correct size and within tolerance.
D. Verify location and size of machine foundation and position of machine foundation bolts.
E. Verify that electrical power is available and of correct characteristics.

3.02 INSTALLATION

A. Install MRL electric traction elevator systems in accordance with manufacturer's instructions, ASME A17.1, and NFPA 70.
B. Install system components, and connect equipment to building utilities.

C. Install machinery, guides, controls, car and all equipment and accessories to provide a quiet, smoothly operating installation, free from side sway, oscillation or vibration
D. Mount machines and motors on vibration and acoustic isolators.
   1. Place on structural supports and bearing plates.
   2. Securely fasten to building supports.
   3. Prevent lateral displacement.
E. Install hoistway, elevator equipment, and components in accordance with approved shop drawings.
F. Install guide rails to allow for expansion and contraction movement of guide rails.
G. Accurately machine and align guide rails, forming smooth joints with machined splice plates.
H. Install hoistway door sills, frames, and headers in hoistway walls; grout sills in place, set hoistway floor entrances in alignment with car openings, and align plumb with hoistway.
   1. At masonry and concrete walls, fill hoistway door frames solid with grout in accordance with Section 04 2000 - Unit Masonry and as follows:
      a. Grout to have maximum 4 inch slump for hand troweling; thinner pumpable grout is prohibited.
   2. At stud walls, fill head and jamb members with mineral fiber insulation prior to installation.
I. Adjust equipment for smooth and quiet operation.

3.03 TOLERANCES

A. Guide Rail Alignment: Plumb and parallel to each other in accordance with ASME A17.1 and ASME A17.2.
B. Car Movement on Aligned Guide Rails: Smooth movement, without any objectionable lateral or oscillating movement or vibration.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Acceptance testing: Upon completion of the elevator installation and before permitting use of elevator, perform acceptance tests as required by Code and authorities having jurisdiction (AHJ).
   1. Schedule tests and notify Architect two weeks in advance.
   2. Perform tests required by regulatory agencies.
   3. Inspectors shall be certified in accordance with ASME QEI-1.
   4. Perform tests in accordance with ASME A17.2.
   5. Document tests and inspections in accordance with requirements.
   6. Furnish test and approval certificates issued by authorities having jurisdiction (AHJ).

3.05 ADJUSTING

A. Adjust for smooth acceleration and deceleration of car to minimize passenger discomfort.
B. Adjust with automatic floor leveling feature at each floor landing to reach 1/4 inch maximum from flush with sill.

3.06 CLEANING

A. Remove protective coverings from finished surfaces.
B. Clean surfaces and components in accordance with manufacturers written instructions.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. Demonstration: Demonstrate operation of system to Owner's personnel.
   1. Use operation and maintenance data as reference during demonstration.
   2. Briefly describe function, operation, cleaning and maintenance of each component.

3.08 PROTECTION

A. Do not permit construction traffic within car after cleaning.
B. Protect installed products until Date of Substantial Completion.

C. Touch-up, repair, or replace damaged products and materials before Date of Substantial Completion.

3.09 MAINTENANCE

A. Refer to Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to initial maintenance service.
B. Provide Initial Maintenance Contract of elevator system and components in accordance with ASME A17.1 and requirements as indicated for twelve months from Date of Substantial Completion.
C. Submit proposal for continuation of Maintenance Contract in accordance with ASME A17.1 and requirements as indicated for installed elevator equipment.
D. Perform maintenance contract services using competent and qualified personnel under the supervision and direct employ of the elevator manufacturer or installer.
E. Maintenance contract services shall not be assigned or transferred to any agent or other entity without prior written consent of Owner.
F. Examine system components bi-monthly.
G. Include systematic examination, adjustment, and lubrication of elevator equipment.
H. Maintain and repair or replace parts, whenever required, using parts produced by original equipment manufacturer.
I. Perform work without removing cars from use during peak traffic periods.
J. Provide emergency call back service for 24 hours a day/7 days a week throughout period of this maintenance contract.
K. Maintain an adequate stock of parts for replacement or emergency purposes, and have personnel available to ensure the fulfillment of this maintenance contract without unreasonable loss of time.

END OF SECTION 14 2123.16

SECTION 20 0500 - MECHANICAL GENERAL REQUIREMENTS

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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 work of this Section.

1.02 SUMMARY

A. This Section includes mechanical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 01 Specification Sections.

1.03 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
3. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
4. ABMA - American Boiler Manufacturers Association; www.abma.com.
5. AGA - American Gas Association; www.aga.org.
6. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
7. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.

8. ANSI - American National Standards Institute; www.ansi.org.
9. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
10. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
11. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
12. ASTM - ASTM International; www.astm.org.
13. AWS - American Welding Society; www.aws.org.
14. AWWA - American Water Works Association; www.awwa.org.
15. CDA - Copper Development Association; www.copper.org.
16. CGA - Compressed Gas Association; www.cganet.com.
17. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
18. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
19. CSI - Construction Specifications Institute (The); www.csiresources.org.
20. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
21. FM Approvals - FM Approvals LLC; www.fmglobal.com.
22. HI - Hydraulic Institute; www.pumps.org.
23. ICC - International Code Council; www.iccsafe.org.
24. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
25. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
26. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
27. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org
28. NADCA - National Air Duct Cleaners Association; www.nadca.com.
29. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
30. NEBB - National Environmental Balancing Bureau; www.nebb.org.
31. NECA - National Electrical Contractors Association; www.necanet.org.
32. NEMA - National Electrical Manufacturers Association; www.nema.org.
33. NETA - InterNational Electrical Testing Association; www.netaworld.org.
34. NFPA - National Fire Protection Association; www.nfpa.org.
35. NSF - NSF International; www.nsf.org.
36. NSPE - National Society of Professional Engineers; www.nspe.org.
37. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
38. STI - Steel Tank Institute; www.steeltank.com.
39. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.

40. UL - Underwriters Laboratories Inc.; www.ul.com.

41. USGBC - U.S. Green Building Council; www.usgbc.org.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.04 **PERFORMANCE REQUIREMENTS**

A. Systems Components Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

1.05 **QUALITY ASSURANCE**

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified and as indicated on Drawings.

1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.

1. Notify the Architect/Engineer in writing before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations.

2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to A/E, the Contractor shall bear all costs arising from corrective measures.

C. Source Limitations: Obtain equipment and other components of the same or similar systems through one source from a single manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Perform work to avoid interference with the work of other trades. Remove and relocate work which in the opinion of the Owner’s Representatives causes interference.

G. Labeling Requirement for Packaged Equipment: Electrical panels on packaged mechanical equipment shall bear UL label or label of other Nationally Recognized Testing Laboratory (NRTL) (Intertek, CSA, etc.).

1.06 **CODES, PERMITS AND FEES**

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for Mechanical Work shall be secured and paid for by the Contractor. All Work shall conform to all applicable codes, rules and regulations.

B. Rules of local utility companies shall be complied with. Check with each utility company supplying service to the installation and determine all devices including, but not limited to, all valves, meter boxes, and meters which will be required and include the cost of all such items in proposal.

C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

D. Refer to Division 22 Section “Domestic Water Piping” for purchase and installation of potable water meters.

1.07 **DRAWINGS**

A. The drawings show the location and general arrangement of equipment, piping and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly. Provide fittings, valves, and accessories as required to meet actual conditions.

C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The Architectural and Structural Drawings take precedence in all matters pertaining to the building structure, Mechanical Drawings in all matters pertaining to Mechanical Trades and Electrical Drawings in all matters pertaining to Electrical Trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.08 **MATERIAL AND EQUIPMENT MANUFACTURERS**

A. Equipment: All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, piping, sheet metal, electrical work, and building alterations shall be included in the original Bid.

C. All package unit equipment and skid mounted mechanical components that are factory assembled shall meet, in detail, the products named and specified within each section of the Mechanical and Electrical Specifications.

D. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment scheduled on the Drawings. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified with no additional cost to project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1. Where equipment changes are made that involve additional Electrical Work (larger size motor, additional wiring of equipment, etc.) the Mechanical Trades involved shall compensate the Electrical Trades for the cost of the additional Work required.

1.09 **INSPECTION OF SITE**

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

B. No contract sum adjustments or contract time extensions will be made for Contractor claims arising from conditions which were or could have been observable, ascertainable or reasonably foreseeable from a site visit or inquiry into local conditions affecting the execution of the work.

1.10 **ITEMS REQUIRING PRIOR APPROVAL**

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 01 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.

2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, piping, sheet metal, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid, but will not affect the awarding of the contract.

1.11 **SUBMITTALS**

A. Submit project specific submittals for review in compliance with Division 01.

B. Prepare shop drawings to scale for the Architect/Engineer for review. Equipment and material submittals required are indicated in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating and Air Conditioning Sections. Refer to Division 01 for submittal quantities.

C. All submittals shall be submitted in groupings of similar and/or related items. Plumbing fixture submittals shall be submitted as one package including all fixtures intended to be used for this project. Incomplete submittal groupings will be returned “Rejected”. Submit shop drawing with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.

D. All submittals shall be project specific. Standard detail drawings and schedule not clearly indicating which data is associated with this Project will be returned “Rejected”.

E. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.

F. No equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. Review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action indicated is subject to the requirement of the plans and specifications.

1. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.

2. Contractor is responsible for:

a. Dimensions, which shall be confirmed and correlated at the job site.

b. Fabrication processes and techniques of construction.

c. Quantities.

d. Coordination of Contractor’s work with all other trades.

e. Satisfactory performance of Contractor’s work.

f. Temporary aspects of the construction process.

G. Submit detailed shop drawings of piping systems showing pipe routing and types and locations of all pipe hangers.

H. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

1.12 COORDINATION DRAWINGS

A. Submit project specified coordination drawings for review in compliance with Division 01 Specification Sections.

1.13 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all mechanical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. One copy of all manuals shall be furnished for Owner. Maintenance and operating instructional manuals shall be provided when construction is approximately 75 percent complete.

C. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.

b. Enable inserted reviewer comments on draft submittals.

D. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:

1. Routine maintenance procedures.
2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
3. Trouble-shooting procedures.
4. Contractor's telephone numbers for warranty repair service.
5. Submittals.
6. Recommended spare parts list.
7. Names and telephone numbers of major material suppliers and subcontractors.
8. System schematic drawings.

1.14 **RECORD DRAWINGS**

A. Submit record drawings in compliance with Division 01.

B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or vellum which have been neatly marked to represent as-built conditions for all new mechanical work.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.15 **INSTRUCTION OF OWNER PERSONNEL**

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 24 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.

C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.

E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.16 **WARRANTY**

A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 REFRIGERANT HANDLING

A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:

1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
3. United States Environmental Protection Agency (US EPA) requirements of Section 8 08 (Prohibition of Venting and Regulation of CFC) and applicable State and Local regulations of authorities having jurisdiction.

B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations.

3.02 TEMPORARY SERVICES

A. Provide temporary service as described in Division 01.

B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional cost to the Owner.

3.03 WORK INVOLVING OTHER TRADES

A. Certain items of equipment or materials specified in the Mechanical Division may have to be installed by other trades due to code requirements or union jurisdictional requirements. In such instances, the Contractor shall complete the work through an approved, qualified subcontractor and shall include the full cost for same in proposal.

3.04 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.

B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.

C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.

D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

E. Operation of the following systems shall be demonstrated:

1. Air Handling Systems.
2. Refrigeration Systems.
3. Heating Systems.
4. Domestic Water Booster Systems.
5. Domestic Hot Water Heaters.
6. Domestic Hot Water Mixing Stations.

7. Temperature Controls.
8. Building Automation System.
9. Exhaust Systems.

F. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

END OF SECTION

SECTION 20 0510 - BASIC MECHANICAL MATERIALS AND METHODS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”

2. Division 22 Section “Domestic Water Piping” for flushing and cleaning of potable water piping.

3. Division 23 Section “Piping Systems Flushing and Chemical Cleaning” for flushing and cleaning of HVAC piping.

1.02 **SUMMARY**

A. This section includes mechanical materials and installation methods common to mechanical piping systems, sheet metal systems and equipment. This section supplements all other Division 20, 21, 22, and 23 Mechanical Sections, and Division 01 Specification Sections.

1.03 **DEFINITIONS**

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.

3. PE: Polyethylene plastic.

4. PVC: Polyvinyl chloride plastic.

5. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

6. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.04 **SUBMITTALS**

A. Product Data: For the following:

1. Transition fittings.

2. Dielectric fittings.

3. Mechanical sleeve seals.

4. Escutcheons.

B. Welding certificates.

C. Brazing Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

1.05 **QUALITY ASSURANCE**

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

B. Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

D. Comply with NSF 372, “Drinking Water System Components – Lead Content” for potable domestic water piping and components.

E. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

F. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

G. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

H. Soldering: Qualify processes and operators according to AWS B2.3/2.3M, "Specification for Soldering Procedure and Performance Qualification."

I. Installer Qualifications:

1. Installers of Grooved Components: Installers shall be certified by the grooved component manufacturer as having been trained and qualified to join piping with grooved couplings, fittings, and specialties.

2. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

3. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

1.06 **DELIVERY, STORAGE, AND HANDLING**

A. Storage and Protection: Provide adequate weather protected storage space for all mechanical equipment and materials deliveries to the job site. Storage locations will be designated by the Owner’s Representative. Equipment stored in unprotected areas must be provided with temporary protection.

1. Protect equipment and materials from theft, injury or damage.

2. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.

3. Materials with enamel or glaze surface shall be protected from damage by covering and/or coating as recommended in bulletin “Handling and Care of Enameled Cast Iron Plumbing Fixtures”, issued by the Plumbing Fixtures Manufacturer Association, and as approved.

4. Electrical equipment furnished by Mechanical Trades and installed by the Electrical Trades: Turn over to Electrical Trades in good condition, receive written confirmation of same.

5. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

6. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.07 **COORDINATION**

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations. Coordinate with other trades to ensure accurate locations and sizes of mechanical spaces, chases, slots, shafts, recesses and openings.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Install Work to avoid interference with work of other trades including, but not limited to, Architectural and Electrical Trades. Remove and relocate any work that causes an interference at Contractor's expense.

D. Coordinate requirements for and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

E. The mechanical trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.

1. All patching and repair of any such damaged work shall be performed by the trades which installed the work. The cost shall be paid by the Mechanical Trades.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 **PIPE, TUBE, AND FITTINGS**

A. Refer to individual Division 21, 22, and 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 **JOINING MATERIALS**

A. Refer to individual Division 21, 22, and 23 piping Sections for special joining materials not listed below.

B. Unions: Pipe Size 2 Inches and Smaller:

1. Ferrous pipe: Malleable iron ground joint type unions.

2. Unions in galvanized piping system shall be galvanized.

3. Copper tube and pipe: Bronze unions with soldered joints.

C. Flanges: Pipe Sizes 2-1/2 Inch and Larger:

1. Ferrous pipe: Standard weight, forged steel weld neck flanges.

2. Copper tube and pipe: Slip-on bronze flanges.

D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. Square head bolts and nuts are not acceptable.

F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

G. Solder Filler Metals: ASTM B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.

H. Brazing Filler Metals: Alloys meeting AWS A5.8.

1. Use Type BcuP Series, silver-bearing, copper-phosphorus alloys for joining copper or bronze socket fittings with copper pipe. Flux is prohibited unless used with bronze fittings.

2. Use Type Bag Series, cadmium-free silver alloys for joining copper with steel, stainless steel, or other ferrous alloys.

I. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

K. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

L. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

M. Solvent Cements for Joining ABS Piping: ASTM D 2235.

N. Solvent Cements for Joining PVC to ABS Piping Transition: ASTM D 3138.

O. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.04 PIPE THREAD COMPOUNDS

A. Pipe thread compounds for the fluid service compatible with piping materials provided.

B. Compounds for potable water service and similar applications acceptable to U.S. Department of Agriculture (USDA) or Food and Drug Administration (FDA). Compounds containing lead are prohibited.

C. Inorganic zinc-rich coatings or corrosion inhibited proprietary compounds for galvanized carbon steel systems to coat raw carbon steel surfaces, in lieu of subsequent painting.

1. Manufacturers:
    a. Carboline "Carbo-Zinc 12."
    b. Tnemec.
    c. Koppers.

D. Graphite and oil or proprietary corrosion inhibited compounds suitable for system temperatures for steam or condensate.
    1. Manufacturers:
        a. WKM; Division of Cooper Industries, Inc., Key "Graphite Paste."
        b. Other approved.

E. Use tetrafluoroethylene (Teflon) tape 2 to 3 mils thick for natural gas system threaded joints.
    1. Manufacturers:
        a. Cadillac Plastic.
        b. Permacel.
        c. Other approved.

2.05 **TRANSITION FITTINGS**

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
    1. Manufacturers:
        a. Cascade Waterworks Mfg. Co.
        b. Dresser Industries, Inc.; DMD Div.
        c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
        d. JCM Industries.
        e. Smith-Blair, Inc.
        f. Viking Johnson.
    2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
    3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
    4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
    1. Manufacturers:
        a. IPEX Inc. (formerly Eslon Thermoplastics).

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
    1. Manufacturers:
        a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

a. NIBCO INC.

b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Fernco, Inc.

c. Mission Rubber Company.

d. Plastic Oddities, Inc.

e. Can-Tex Industries Division of Harsco Corp. “CT-Adaptors”.

f. Joint Inc., “Caulder”.

2.06 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Brass Unions, Brass Nipples, Brass Couplings: For systems up to 286 deg F.

D. Dielectric-Flange Kits: Include full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Capitol Manufacturing Co.

d. GF Piping Systems; George Fischer Central Plastics.

e. Epco Sales, Inc.

f. Pipeline Seal and Insulator, Inc.

g. Watts Water Technologies, Inc.; Watts Regulator Co.

h. Zurn Industries, Inc.; Wilkins Div.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Nipple/Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, male NPT threaded, or grooved ends; and 300-psig minimum working pressure at 230 deg F.

1. Manufacturers:

a. Anvil International, Inc.; Gruvlok Manufacturing; DI-LOK Nipples.

b. Elster Group; Perfection Corp.; ClearFlow.

c. Precision Plumbing Products, Inc.; ClearFlow.

d. Sioux Chief Manufacturing Co., Inc.

e. Tyco Fire & Building Products; Grinnell Mechanical Products; Figure 407 ClearFlow.

f. Victaulic Co. of America; Style 47 ClearFlow.

2.07 MODULAR MECHANICAL SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve or pipe and core drilled hole.

1. Manufacturers:

a. Advance Products & Systems, Inc.; Innerlynx.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.; Thunderline Link Seal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.08 SLEEVES

A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall black.

B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall galvanized, plain ends.

C. Water Stop: Cast or ductile-iron; fabricated steel; PVC; or rotationally molded HDPE pipe; with plain ends and integral water stop, unless otherwise indicated.

1. Manufacturers:

a. Advance Products & Systems, Inc.; Infinity and Gal-Vo-Plast Sleeves.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.09 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping or Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.

e. Bare Piping in Unfinished Service Spaces or Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.

2.10 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.11 EPOXY BONDING COMPOUND

A. Two-component system suitable for bonding wet or dry concrete to each other and to other materials.

B. Manufacturers:

1. Euco 452 #450; Euclid Chemical Co.

2. Epobond; L & M Construction Chemicals.

3. Sikadur 87; Sika Corp.

2.12 PIPE ROOF PENETRATION ENCLOSURES

A. Manufacturers:

1. Pate Company (The); pca Series.

2. Portals Plus, Inc.

3. Thybar Corporation; Thycurb.

B. Prefabricated roof curb with:

1. Minimum 18 gage welded galvanized steel construction.

2. Integral base plate.

3. Factory installed insect and decay resistant wood nailer.

4. Factory installed 1-1/2 inch thick, 3 pounds per cubic foot density rigid insulation.

5. EPDM compression molded rubber cap for single or multiple pipes as required.

6. Stainless steel draw-band clamps.

PART 3 EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Refer to piping application schedules on the Drawings.

B. Install piping according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems, and in accordance with manufacturer’s instructions.

C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. The Drawings shall be followed as closely as elements of construction will permit.

D. During the progress of construction, protect open ends of pipe, fittings, and valves to prevent the admission of foreign matter. Place plugs or flanges in the ends of all installed work whenever work stops. Plugs shall be commercially manufactured products.

E. Prior to and during laying of pipe, maintain excavations dry and clear of water and extraneous materials. Provide minimum 4 inches of clearance in all directions for pipe passing under or through building grade beams.

F. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells in steel pipe. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

G. Brazolets can be used for annular flow measuring devices, temperature control components, and thermal wells in copper tube. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

H. Clean and lubricate elastomer joints prior to assembly.

I. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

J. Install piping to conserve building space and not interfere with use of space.

K. Group piping whenever practical at common elevations.

L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

1. Install piping to allow for expansion and contraction at locations where piping crosses building or structure expansion joints.

M. Slope piping and arrange systems to drain at low points.

N. Slope horizontal piping containing non-condensable gases 1 inch per 100 feet, upward in the direction of the flow.

O. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

P. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

Q. In concealed locations where piping, other than black steel, cast-iron, or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1-1/2 inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1/16 inch thick steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches above sole plates and below top plates.

R. Do not penetrate building structural members unless specifically indicated on drawings.

S. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.

T. Install valves with stems upright or horizontal, not inverted.

U. Provide clearance for installation of insulation and access to valves and fittings.

V. Install piping to permit valve and equipment servicing. Do not install piping below valves and/or terminal equipment. Do not install piping above electrical equipment.

W. Install piping at indicated slopes. Provide drain valves with hose end connections and caps at all piping low points, where piping is trapped and at all equipment.

X. Install piping free of sags and bends.

Y. Install fittings for changes in direction and branch connections.

Z. Unless otherwise indicated or specified, install branch connections to mains using tee fittings in main pipe:

1. Branch connected to bottom of main pipe for HVAC systems. Side connection is acceptable. Connection above centerline of main is unacceptable. For up-feed risers, connect branch to top of main pipe.

2. Branch connected to top of main for steam and condensate, plumbing systems, compressible gasses, and vacuum.

AA. Install piping to allow application of insulation.

BB. Select system components with pressure rating equal to or greater than system operating pressure.

CC. After completion, fill, clean, and treat systems. Refer to Division 23 Sections “Hydronic Piping,” “Piping Systems Flushing and Chemical Cleaning,” and “HVAC Water Treatment.”

DD. Install escutcheons for penetrations of walls below ceiling, and ceilings.

EE. Sleeves are not required for core-drilled holes in poured concrete walls.

FF. Permanent sleeves are not required for holes formed by removable PE sleeves in poured concrete walls.

GG. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces of walls.

a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.

b. 0.375 Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.

c. Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.

d. 0.375 Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.

e. For pipes penetrating floors with membrane water proofing provide cast iron sleeve with clamping flanges. Secure/seal membrane to sleeves with clamping flanges.

4. Seal sleeves in concrete floors roof slabs and masonry walls with grout.

5. Seal sleeves in plaster/gypsum-board partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.

6. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

HH. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.

1. Install Schedule 40 galvanized steel pipe for sleeves smaller than 12 inches in diameter.

2. Install 0.375 galvanized steel pipe for sleeves 12 inches and larger in diameter.

3. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

II. New, Poured Concrete, Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Install water stop sleeves prior to pour. Seal pipe penetrations using modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.

1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

JJ. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

1. Seal openings around pipes in sleeves through walls, floors and ceilings, and where floors, fire rated walls and smoke barriers are penetrated. Firestop materials shall be UL listed and shall have a fire rating equal to or greater than the penetrated barrier.

2. Refer to Division 07 Specification Sections for materials and UL Classified firestop systems.

KK. Pipe Roof Penetration Enclosures:

1. Coordinate delivery of roof penetration enclosures to jobsite.

2. Locate and set curbs on roof.

3. Framing, flashing, and attachment to roof structure are specified under Division 07.

4. Attach cap to curbs, cut pipe boots to fit pipe, and clamp boots to pipe or conduit.

LL. Verify final equipment locations for roughing-in.

MM. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems.

B. Cut piping square.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, oil, and debris from inside and outside of pipe and fittings before assembly.

E. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

F. Use standard long sweep pipe fittings for changes in direction. No mitered joints or field fabricated pipe bends will be permitted. Short radius elbows may be used where specified or specifically authorized by the Architect.

G. Make tee connections with screwed tee fittings, soldered fittings or specified welded connections. Make welded branch connections with either welding tees or forged branch outlet fittings in accordance with ASTM A234, ANSI B16.9 and ANSI B16.11. For forged branch outlets, furnish forged fittings flared for improved flow where attached to the run, reinforced against external strains and to full pipe-bursting strength requirements. "Fishmouth" connections are not acceptable.

H. Use eccentric reducers for drainage and venting of pipe lines; bushings are not permitted.

I. Provide pipe openings using fittings for all systems control devices, thermometers, gauges, etc. Drilling and tapping of pipe wall for connections is prohibited.

J. Provide temperature sensing device thermal wells and similar piping specialty connections.

K. Provide instrument connections except thermal wells with specified isolating valves at point of connection to system.

L. Locate instrument connections in accordance with manufacturer’s instructions for accurate read-out of function sensed. Locate instrument connections for easy reading and service of devices.

M. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

N. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

O. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

P. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

1. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

Q. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on gaskets and bolt threads.

1. Assemble flanged joints with fresh-stock gasket and hex head nuts, bolts or studs. Make clearance between flange faces such that the connections can be gasketed and bolted tight without strain on the piping system. Align flange faces parallel and bores concentric; center gaskets on the flange faces without projection into the bore.

2. Lubricate bolts before assembly to insure uniform bolt stressing. Draw up and tighten bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Do not mate a flange with a raised face to a companion flange with a flat face; machine the raised face down to a smooth matching surface and use a full face gasket. After the piping system has been tested and is in service at its maximum temperature, check bolting torque to provide required gasket stress.

R. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Galvanized piping shall be cut grooved to prevent damage to galvanizing on internal pipe surfaces. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer’s representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

S. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

T. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

U. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Refer to Application Schedules on the Drawings.

V. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.

3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

5. PVC Nonpressure Piping: Join according to ASTM D 2855.

6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

W. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

X. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

Y. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

Z. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

AA. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.

3.03 **ACCESS DOORS**

A. Provide access doors for installation by architectural trades. Provide access doors in the walls, as required to make all valves, controls, coils, motors, air vents, filters, electrical boxes and other equipment installed by the Contractor accessible. Minimum size 12 inches x 12 inches. Provide access doors in the ceiling, for accessibility as mentioned above, 24 inches x 24 inches minimum size. Areas with accessible ceilings (ceilings where lay-in panels are not fastened in place and can be individually removed without removal of adjacent tiles) will not require access doors. Refer to Division 08 Section “Access Doors and Frames” for manufacturers and model numbers and additional information.

B. When access doors are in fire resistant walls or ceilings, they shall bear the Underwriters' Laboratories, Inc., Label, with time design rating equal to or greater than the wall or ceiling unless they were a part of the tested assembly.

3.04 **EQUIPMENT CONNECTIONS**

A. Make connections to equipment, fixtures, and other items included in the work in accordance with the submittals and rough-in measurements furnished by the manufacturers of the particular equipment furnished.

1. Any and all additional connections not shown on the drawings but shown on the equipment manufacturer’s submittal or required for the successful operation of the equipment shall be installed as part of this Contract at no additional charge to the Owner.

B. All piping connections to pumps, coils, and other equipment shall be installed without strain at the pipe connection of this equipment. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

3.05 **PIPING CONNECTIONS**

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

2. Install flanges, in piping NPS 2-1/2 and larger, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

3.06 **EQUIPMENT INSTALLATION - COMMON REQUIREMENTS**

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated. Housekeeping pad locations and sizes shall be coordinated by mechanical contractor prior to the placement of concrete slabs.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. For suspended equipment, furnish and install all inserts, rods, structural steel frames, brackets and platforms required. Obtain approval of Architect for same including loads, locations and methods of attachment.

F. Equipment Rigging Over Roof Areas: Protect building structure against damage during equipment rigging. Make provisions to distribute load of equipment to main roof structure, and to prevent damage to roof decking, roofing, or purlins.

G. The Contract Documents indicate items to be purchased and installed. The items are noted by a manufacturer's name, catalog number and/or brief description. The catalog number may not designate all the accessory parts for a particular application. Arrange with the manufacturer for the purchase of all items required for a complete installation.

3.07 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.08 CONCRETE BASES

A. Concrete housekeeping pads for floor mounted mechanical equipment shall be provided by Architectural Trades.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.

1. Construct concrete bases as shown on Drawings or specified, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section.

3.09 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Where pipe and/or equipment support members must be welded to structural building framing, Contractor shall seek prior approval from Architect and structural engineer. Scrape, brush clean, and apply one coat of zinc rich primer after welding.

D. Field Welding: Comply with AWS D1.1.

3.10 EPOXY BONDING TO EXISTING MATERIALS

A. Use epoxy bonding compound to set sleeves or pipes in existing concrete to bond new concrete and/or grout to existing materials or to bond dissimilar materials.

B. The compound, when applied in accordance with the manufacturer's instructions, shall be capable of initial curing within 48 hours at temperatures as low as 40 deg F and shall be capable of bonding any combination of the following properly prepared materials: Wet or dry, cured or uncured concrete or mortar; vitrified clay; cast iron and carbon steel.

3.11 **JACKING OF PIPE**

A. Do not jack pipe in place except upon prior approval of proposed materials and complete details of methods.

3.12 **ERECTION OF WOOD SUPPORTS AND ANCHORAGES**

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.13 **GROUTING**

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.14 **CUTTING, CORING AND PATCHING**

A. Refer to Division 01 Specification Sections for requirements for cutting, coring, patching and refinishing work necessary for the installation of mechanical work.

B. All cutting, coring, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.15 **EXCAVATION AND BACKFILLING**

A. Refer to Division 31 Specification Sections.

B. Provide all excavation, trenching, tunneling and backfilling required for the mechanical work.

C. Provide all pumping and/or well pointing required for the mechanical work.

D. Provide foundations if required to support underground piping.

E. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

3.16 **FLASHING**

A. Provide all flashing required for mechanical work. Refer to Division 07 Specification Sections.

3.17 LUBRICATION

A. Provide all lubrication for the operation of the equipment until acceptance by the Owner. Contractor is responsible for all damage to bearings up to the date of acceptance of the equipment. Protect all bearings and shafts during installation. Thoroughly grease steel shafts to prevent corrosion. Provide covers as required for proper protection of all motors and other equipment during construction.

3.18 FILTERS

A. Provide and maintain filters in air handling systems throughout the construction period and prior to final acceptance of the building. Do not run air handling equipment, without all prefilters and final filters as specified.

B. Immediately prior to final building acceptance by the Owner, Contractor shall:

1. Replace all disposable type air filters with new units.

3.19 CLEANING

A. Each Mechanical Trade shall be responsible for removing all debris daily as required to maintain the work area in a neat, orderly condition.

B. After equipment, steam, condensate and HVAC water piping systems have been completed and tested, each entire system shall be cleaned and flushed. Refer to Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.

C. Flushing, cleaning, and disinfection of domestic water piping is specified in Division 22 Section “Domestic Water Piping.”

D. Exterior surfaces of all piping, ductwork and equipment shall be wiped down to remove excess dirt and debris prior to concealment by Architectural Trades work.

E. Upon completion of work in each respective area, clean and protect work. Just prior to final acceptance, perform additional cleaning as necessary to provide clean equipment and areas to the Owner.

END OF SECTION

SECTION 20 0513 - MOTORS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section "Mechanical Vibration Controls" for mounting motors and vibration isolation devices.
3. Division 20 Section “Variable Frequency Controllers”.
4. Division 21, 22, and 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.
5. Division 26 Section “Enclosed Switches and Circuit Breakers”.
6. Division 26 Section “Enclosed Controllers”.
7. Division 26 Section “Fuses”.

1.02 SUMMARY

A. This Section includes basic requirements for factory-installed motors.

1.03 DEFINITIONS

A. ABMA: American Bearing Manufacturers Association. (Formerly AFBMA: Anti-Friction Bearing Manufacturers Association.)

B. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

C. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

D. Packaged Self Contained Equipment: Equipment which includes component mechanical and electrical equipment mounted on common bases, skids or frames or in common enclosures with internal control and power wiring factory installed and ready to accept a single electrical service connection. Provide the equipment complete with enclosed controllers, main disconnect switches, control transformers, control devices, wiring and accessories as required.

1.04 **QUALITY ASSURANCE**

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.05 **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.

1.06 **COORDINATION**

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:

1. Compatible with the following:

a. Magnetic controllers.

b. Multispeed controllers.

c. Reduced-voltage controllers.

d. Solid-state controllers.

e. Variable frequency controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.

3. Matched to torque and horsepower requirements of the load.

4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate electrical scope of work to be provided by Division 20, 21, 22, and 23 with this Section, related Division 20, 21, 22, and 23 Specifications, Division 26 Specifications and the Drawings.

C. Electrical work provided under Division 20, 21, 22, and 23: Furnish UL Listed components in accordance with this section, Division 26, and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.

D. Furnished, installed and wired under Division 20, 21, 22, and 23 unless otherwise indicated:

1. Disconnected components in packaged self-contained equipment that are so constructed that components of wiring must be disconnected for shipment and reconnected after installation.

E. Furnished and installed under Division 20, 21, 22, and 23 and wired under Division 26 unless otherwise indicated:

1. Motors required for mechanical equipment
2. Packaged Self-Contained Equipment:
    a. Provide equipment ready to accept a single electrical service connection.
    b. For equipment with remote mounted control panels, provide mounting of the control panel and external wiring from the control panel to the package self-contained equipment.
3. Variable frequency controllers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

1. Dayton.
2. Toshiba Intl.
3. Baldor Electric/Reliance.
4. Rockwell Automation/Allen-Bradley.
5. Nidec Motor Corporation; U.S. Electrical Motors.
6. Regal Beloit/GE Commercial Motors.
7. Regal Beloit/Leeson.
8. Regal Beloit/Marathon.
9. Siemens.

2.02 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed motors except as follows:

1. Different ratings, performance, or characteristics for a motor are specified in another Section.
2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
3. Submersible motors integral to pumps and excluded from NEMA and EISA standards.

B. Electrical Power Supply Characteristics: Coordinate electrical system requirements with Division 26.

C. Electrical Power System Characteristics: As scheduled on the Drawings.

D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

2.03 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase, unless otherwise indicated.

B. Motors Smaller Than 1/2 HP: Single phase, unless otherwise indicated.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Brake Horsepower Input: Shall not exceed 90 percent of the rated motor horsepower.

I. Enclosure: Open dripproof (ODP) for motors installed indoors and out of the airstream. Totally-enclosed fan-cooled (TEFC) for motors installed outdoors or within the airstream.

2.04 **POLYPHASE MOTORS**

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Fire pump motors, C-face motors, JP and JM frame motors, and motors over 200 horsepower shall be energy efficient motors. Efficiency of the motor shall be determined based on the NEMA MG1. The minimum efficiencies, nominal efficiencies and shall meet or exceed Table 12-11.

	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
1	82.5	81.5	82.5	81.5
1.5	84	82.5	84	82.5
2	84	82.5	84	82.5
3	86.5	85.5	87.5	86.5
5	87.5	86.5	87.5	86.5
7.5	88.5	87.5	89.5	88.5
10	89.5	88.5	89.5	88.5
15	91	90.2	91	90.2
20	91	90.2	91	90.2
25	91.7	91	92.4	91.7
30	92.4	91.7	92.4	91.7
40	93	92.4	93	92.4
50	93	92.4	93	93
60	93.6	93	93.6	93
75	94.1	93.6	94.1	93.6
100	94.1	93.6	94.5	94.1
125	94.5	94.1	94.5	94.1
150	95	94.5	95	94.5
200	95	94.5	95	94.5

	1200 RPM OPEN DRIP-PROOF MOTORS 6 POLE		3600 RPM OPEN DRIPPROOF MOTORS 2 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
1	80	78.5	--	--
1.5	84	82.5	82.5	81.5

	1200 RPM OPEN DRIP-PROOF MOTORS 6 POLE		3600 RPM OPEN DRIPPROOF MOTORS 2 POLE	
HP	NOMINAL EFF	MINIMUM EFF	NOMINAL EFF	MINIMUM EFF
2	85.5	84	84	82.5
3	86.5	85.5	84	82.5
5	87.5	86.5	85.5	84
7.5	88.5	87.5	85.5	86.5
10	90.2	89.5	88.5	87.5
15	90.2	89.5	89.5	88.5
20	91	90.2	90.2	89.5
25	91.7	91	91	90.2
30	92.4	91.7	91	90.2
40	93	92.4	91.7	91
50	93	93	92.4	91.7
60	93.6	93	93	92.4
75	93.6	93	93	92.4
100	94.1	93.6	93	92.4
125	94.1	93.6	93.6	93
150	94.5	94.1	93.6	93
200	94.5	94.1	94.5	94.1

C. Efficiency: Motors 1 horsepower to 200 horsepower shall be premium efficient motors meeting requirements of NEMA Premium Efficiency Motor Program. Efficiency of the motor shall be determined based on the NEMA MG1. The nominal efficiencies shall meet or exceed Table 12-12.

Nominal Efficiencies For “NEMA Premium™” Induction Motors
Rated 600 Volts or Less (Random Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated Medium Volts for 5kV or Less (Form Wound)

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
250	95.0	95.0	94.5	95.0	95.0	95.0
300	95.0	95.0	94.5	95.0	95.0	95.0
350	95.0	95.0	94.5	95.0	95.0	95.0
400	95.0	95.0	94.5	95.0	95.0	95.0
450	95.0	95.0	94.5	95.0	95.0	95.0
500	95.0	95.0	94.5	95.0	95.0	95.0

D. Stator: Copper windings, unless otherwise indicated.

E. Rotor: Squirrel cage, unless otherwise indicated.

F. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 120,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

G. Temperature Rise: Match insulation rating, unless otherwise indicated.

H. Insulation: Class F, unless otherwise indicated.

I. Code Letter Designation:

1. Motors 10 HP and Larger: NEMA starting Code (KVA Code) F or G.

2. Motors Smaller Than 10 HP: Manufacturer's standard starting characteristic.

3. Fire Pump Motors: NEMA starting Code (KVA Code) B.

J. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

1. Finish: Gray enamel.

K. Sound Level: Not to exceed NEMA MG-1 12.54.

2.05 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

B. Shaft Grounding: Provide a means to protect motor from common mode currents.

1. Required for:

a. Motors used with variable frequency controllers.

b. Motors 100 HP and larger.

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

a. Electro Static Technology, Inc.; Aegis SGR Conductive Microfiber.

C. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

2.06 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

2.07 ENCLOSED CONTROLLERS

A. Provide enclosed controllers in accordance with requirements specified in Division 26 Section “Enclosed Controllers”.

2.08 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

A. Provide enclosed switches and circuit breakers in accordance with requirements specified in Division 26 Section “Enclosed Switches and Circuit Breakers”.

2.09 FUSES

A. Provide fuses in accordance with requirements specified in Division 26 Section “Fuses”.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. All three phase motors 1/2 HP and above shall be tested by the Testing Agency.

B. Prepare for acceptance tests as follows:

1. Check motor nameplates for horsepower, speed, phase and voltage.
2. Check coupling alignment and shaft end play.
3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
4. Test interlocks and control features for proper operation.
5. Verify that current in each phase is within nameplate rating.

C. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing

D. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.

2. Jog motor as required to verify proper phase and shaft rotation. Immediately after start-up, check bearing temperature and smooth operation. Take current reading at full load using a clamp-on ammeter. If ammeter reading is over the rated full load current, determine reason for discrepancy and take necessary corrective actions. Record all readings, motor nameplate data and overload heater data.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.02 **ADJUSTING**

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.03 **CLEANING**

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 20 0516 - PIPE FLEXIBLE CONNECTORS, EXPANSION FITTINGS AND LOOPS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Refrigerant Piping.”

1.02 DEFINITIONS

A. BR: Butyl rubber.

B. CR: Chlorosulfonated polyethylene synthetic rubber (Neoprene).

C. CSM: Chlorosulfonyl-polyethylene rubber (Hypalon).

D. EPDM: Ethylene-propylene-diene terpolymer rubber.

E. NBR: Buna-N/Nitrile rubber.

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.

1.03 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 150 percent of maximum axial movement between anchors.

1.04 **SUBMITTALS**

A. Product Data: For each type of pipe flexible connector, expansion joint and alignment guide indicated.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.

2. Locations of pipe anchors and alignment guides and expansion joints and loops.

C. Shop Drawings: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.

2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.

3. Alignment Guide Details: Detail field assembly and attachment to building structure.

4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Welding certificates.

F. Operation and Maintenance Data: For pipe expansion joints to include in operation and maintenance manuals.

1.05 **QUALITY ASSURANCE**

A. Welding: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."

2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **FLEXIBLE CONNECTORS**

A. Rubber Flexible Connectors/Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods or cables, and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

1. Manufacturers:
    a. Flex-Weld, Inc./Keflex.
    b. Mason Industries, Inc.; Mercer Rubber Co.
    c. Metraflex, Inc.
    d. Senior Flexonics, Inc.; Pathway Division.
    e. Twin City Hose, Inc.
    f. Vibration Mountings & Controls, Inc.
2. Arch Type: Single or multiple arches.
3. Spherical Type: Single or multiple spheres.
    a. Working Pressure Ratings for NPS 1-1/2 to NPS 4: 225 psig at 170 deg F.
    b. Working Pressure Ratings for NPS 5 and NPS 6: 225 psig at 170 deg F.
    c. Working Pressure Ratings for NPS 8 to NPS 12: 225 psig at 170 deg F.
    d. Working Pressure Ratings for NPS 14: 150 psig at 170 deg F.
    e. Working Pressure Ratings for NPS 16 to NPS 20: 125 psig at 170 deg F.
    f. Working Pressure Ratings for NPS 24: 110 psig at 170 deg F.
4. Material: EPDM.
5. End Connections: Full-faced, integral, steel flanges with steel retaining rings.

B. Hose and Braid Flexible Connectors:
1. Manufacturers:
    a. Adsco Manufacturing, LLC.
    b. Flex-Weld, Inc.
    c. Hyspan Precision Products, Inc.
    d. Metraflex, Inc.
    e. Senior Flexonics, Inc.; Pathway Division.
    f. Twin City Hose, Inc.
2. Flexible Connectors for Copper Piping: Multiple-ply phosphor-bronze corrugated hose with bronze outer braid, copper ferrule, and copper pipe end connections.
3. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
4. Maximum Temperature Rating: 450 deg F for copper piping connectors, 800 deg F for steel piping connectors.

C. Grooved Mechanical Flexible/Expansion Joint:
1. Manufacturers:
    a. Anvil International, Inc.; Fig. 7420 Expansion Joint.
    b. Victaulic Company; Model 77 Flexible Coupling, W77 AGS Flexible Coupling, and 177N QuickVic Installation-Ready Flexible Coupling.

2. Description: Comprised of multiple flexible style couplings, and precision machined grooved end pipe nipples. Assembly uses factory installed ties to custom preset expansion joint in the expanded, compressed, or intermediate position.

3. Gaskets: Synthetic rubber gasket of central cavity pressure-responsive design suitable for temperatures from minus 30 deg F to 230 deg F.

4. Couplings: Ductile-iron housing with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

   a. Flexible Type: To provide a flexible pipe joint which allows for vibration isolation, expansion, contraction, and deflection. Quantity and arrangement as recommended by manufacturer.

2.03 EXPANSION JOINTS

A. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Manufacturers:

   a. Flex-Hose Co., Inc.

   b. Metraflex, Inc.; Metraloop.

   c. Twin City Hose, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- or brazed- joint end connections.

   a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with minimum 300 psig at 70 deg F and 230 psig at 400 deg F ratings.

   b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 230 psig at 70 deg F and 180 psig at 400 deg F ratings.

3. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged or weld end connections to match piping system for NPS 2-1/2 and larger.

   a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 450 psig at 70 deg F and 325 psig at 600 deg F ratings; and 300 psig maximum saturated steam pressure rating.

   b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 165 psig at 70 deg F and 120 psig at 600 deg F ratings; and 130 psig maximum saturated steam pressure rating.

   c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with minimum 160 psig at 70 deg F and 115 psig at 600 deg F ratings; and 90 psig maximum saturated steam pressure rating.

2.04 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers:

   a. Adsco Manufacturing, LLC.

   b. Flex-Weld, Inc.

c. Hyspan Precision Products, Inc.

d. Metraflex, Inc.

e. Senior Flexonics, Inc.; Pathway Division.

2.05 **SLIDING/GUIDING DEVICES**

A. For pipe size 4 inch and smaller on all hot piping, provide guides equal to Flexonics semi-steel spider and guiding cylinder pipe alignment guides for all expansion joints and loops. Provide pipe alignment guides in quantities at all locations as required according to the manufacturer's design criteria and recommendations. Pipe alignment guides shall serve to guide the expansion joints, loops or bends.

1. Manufacturers:

a. B-Line by Eaton; Figure 3281 Series.

b. Senior Flexonics.

c. Sypris Technologies; Tube Turns Division;

d. U.S. Flexible Metallic Tubing Co., Kelflex Type M.

e. Metraflex, Inc.

B. For pipe sizes 6 inches and above and all guides on cold piping, furnish pre-engineered pre-insulated guides with published vertical and lateral load ratings. Construction shall consist of an insulted shield containing structural calcium silicate (100 psi non-load bearing and 600 psi load bearing) encased in 360 degrees of overlapping sheet metal. A 36 steel clamps torqued onto insulated shield with recommended catalog torque valves. Slide service shall be stainless steel to polyethylene or Teflon with a maximum coefficient of friction of 0.15.

1. Manufacturers:

a. Pipe Shields, Inc. B3000, B4000, B7000 and B8000 series.

b. Carpenter and Paterson, Inc.

c. Rilco Mfg. HG 3000, HG 4000, HG 7000, and HG 8000 series.

2.06 **MATERIALS FOR ANCHORS**

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Stud: Threaded, zinc-coated carbon steel.

2. Expansion Plug: Zinc-coated steel.

3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.

3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi minimum. Refer to Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 FLEXIBLE CONNECTOR APPLICATIONS

A. Use rubber flexible pipe connectors at the inlet and outlet water connections of base mounted pumps, unless otherwise indicated.

1. Rubber Flexible Connectors for Pipe Sized NPS 2 and Smaller: Twin-sphere with females union end connections.

2. Rubber Flexible Connectors for Pipe Sized NPS 2-1/2 and Larger: Twin-sphere with floating flange end connections.

3.02 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

D. Install alignment guides at spacing recommended by expansion joint manufacturer.

E. Control expansion joint movement by installing two rigid pipe guides on each side of the expansion joint. Spacing shall be as follows:

Nom. Pipe Size	Exp. Joint to 1st Guide	1st to 2nd Guide	Maximum Distance Between Intermediate Guides (Ft.) For Tabulated pressures, PSIG							
(In.)			50	100	150	200	250	300	350	400
1	0'-4"	1'-4"	21	15	12					
1 1/4	0'-5"	1'-5"	23	17	13					
1 1/2	0'-6"	1'-9"	28	20	17					
2	0'-8"	2'-4"	32	23	18					
2 1/2	0'-10"	2'11"	35	28	22					
3	1'-0"	3'-6"	21	19	17	16	15	14	13	13
4	1'-4"	4'-8"	35	29	25	22	20	19	18	17
6	2'-0"	7'-0"	57	44	37	32	29	27	25	23
8	2'-8"	9'-4"	66	52	45	40	36	33	31	29
10	3'-4"	11'-8"	91	69	58	51	46	42	39	36
12	4'-0"	14'-0"	107	79	66	58	52	48	44	41
14	4'-8"	16'-4"	115	85	71	62	56	51	47	
16	5'-4"	18'-8"	127	94	78	68	61	56	52	
18	6'-0"	21'-0"	139	102	85	74	67	61	56	

20	6'-8"	23'-4"	151	110	91	80	71
24	8'-0"	28'-0"	172	125	103	89	80
30	10'-0"	35'-0"	200	144	118	103	92

3.03 **PIPE BEND AND LOOP INSTALLATION**

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.04 **SWING CONNECTIONS**

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.05 **ALIGNMENT-GUIDE INSTALLATION**

A. Install guides on piping adjoining pipe expansion joints and bends and loops.

B. Attach guides to pipe and secure to building structure.

3.06 **ANCHOR INSTALLATION**

A. Install anchors at 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 steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION

SECTION 20 0519 - METERS AND GAGES

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 21 Section “Fire-Suppression Piping” for listed or approved pressure gages.
4. Division 22 Section "Water Distribution" for domestic and fire-protection water service meters outside the building.
5. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
6. Division 23 Section "Fuel Gas Piping" for gas utility meters.

1.02 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FPR: Fiberglass reinforced plastic.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for the following indicating manufacturer's number, scale range, and location for each:

1. Thermometers.
2. Gages.

C. Product Certificates: For the following signed by product manufacturer:

1. Thermometers.

2. Gages.

1.04 **QUALITY ASSURANCE**

A. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **METAL-CASE, LIQUID-IN-GLASS THERMOMETERS**

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.

2. Miljoco Corporation.

3. REOTEMP Instrument Corporation.

4. Trerice, H. O. Co.

5. Weiss Instruments, Inc.

6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum or Chrome-plated brass, 9 inches long.

C. Tube: Red, blue, or green reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass or plastic.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.03 **THERMOWELLS**

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer. Brass for compatible services less than 353 degrees F; ANSI 18-8 stainless steel for all others to suit service. Furnish extension neck to accommodate insulation where applicable.

2.04 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Cambridge.
3. Dwyer Instruments, Inc.
4. Marsh Bellofram.
5. Miljoco Corporation.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Stainless steel, aluminum, or FRP, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass or plastic.
8. Ring: Stainless steel or chrome plated metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Water: 0-100 PSIG (1 psi divisions to 50 psi; 5 psi divisions above 50 psi), liquid filled.
11. Range for Fluids under Pressure: 1-1/2 times expected working pressure. If not a standard scale, select next largest scale.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass ball type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.05 TEST PLUGS

A. Manufacturers:

1. Peterson Equipment Co., Inc.
2. Miljoco Corporation.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F for cold services, and 500 psig at 275 deg F for hot services.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be Neoprene.

2. Insert material for air or water service at minus 30 to plus 275 deg F shall be Nordel.

E. Test Kit: Furnish test kit(s) containing one pressure gage and adaptor, thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.

2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.

3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.

4. Carrying case shall have formed instrument padding.

PART 3 EXECUTION

3.01 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.

2. Inlet and outlet of each hydronic boiler and chiller.

3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

4. Inlet and outlet of each hydronic heat exchanger.

5. Inlet and outlet of each hydronic heat-recovery unit.

6. Inlet and outlet of each thermal storage tank.

7. Outside-air, return-air, and mixed-air ducts.

B. Provide the following temperature ranges for thermometers:

1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.

2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.

4. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.02 GAGE APPLICATIONS

A. Install dry-case-type pressure gages on inlet and outlet of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.03 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending to center of pipe a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

C. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install ball valve and snubber fitting in piping for each pressure gage for fluids (except steam).

F. Install ball valve and syphon fitting in piping for each pressure gage for steam.

G. Install test plugs in tees in piping.

H. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

I. Install permanent indicators on walls or brackets in accessible and readable positions.

J. Install connection fittings for attachment to portable indicators in accessible locations.

K. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils.

L. Assemble components and install thermal-energy meters.

M. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.04 **CONNECTIONS**

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy-meter transmitters to meters.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. Connect wiring according to Division 26 Section "Conductors and Cables."

3.05 **ADJUSTING**

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION

SECTION 20 0529 - HANGERS AND SUPPORTS

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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 include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 20 Section “Mechanical General Requirements.”
3. Division 20 Section “Basic Mechanical Materials and Methods.”
4. Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
5. Division 20 Section "Pipe Expansion Fittings and Loops" for pipe guides and anchors.
6. Division 21 Section "Fire-Suppression Piping" for pipe hangers for fire-protection piping.
7. Division 23 Section(s) "Metal Ducts" and "Nonmetal Ducts" for duct hangers and support.

1.02 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. MFMA: Metal Framing Manufacturers Association.

1.03 **PERFORMANCE REQUIREMENTS**

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.04 **SUBMITTALS**

A. Product Data: For the following:

1. Steel pipe hangers and supports.

2. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.

2. Metal framing systems. Include Product Data for components.

3. Pipe stands. Include Product Data for components.

4. Equipment supports.

C. Welding certificates.

1.05 **QUALITY ASSURANCE**

A. MSS Standards: Pipe hangers, supports, and accessories shall comply with the following:

1. MSS SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture, Selection, Application, and Installation.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

2. AWS D1.2, "Structural Welding Code--Aluminum."

3. AWS D1.3, "Structural Welding Code--Sheet Steel."

4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."

5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **HANGER ROD MATERIAL**

A. Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575.

1. Rod continuously threaded.

2. Use of rod couplings is prohibited.

2.03 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article, and schedules and details on the Drawings for where to use specific hanger and support types.

1. Hangers and Supports for Fire Protection Piping: UL listed or FMG approved.

B. Manufacturers:

1. Anvil International, Inc.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. Hilti USA.
5. nVent Electric plc; CADDY.
6. PHD Manufacturing, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.04 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.05 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. Anvil International, Inc.; Anvil-Strut.
2. B-Line by Eaton.
3. Power-Strut; a part of Atkore International.
4. Unistrut; a part of Atkore International.
5. Hilti USA.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

E. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.06 METAL INSULATION SHIELDS

A. Manufacturers:

1. Anvil International, Inc.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. nVent Electric plc; CADDY.

5. PHD Manufacturing, Inc.

B. Description: MSS SP-58, Type 40, protective shields. Shields shall span an arc of 180 degrees.

C. Shield Dimensions for Pipe: Not less than the following:

1. NPS 1/4 to NPS 2: 12 inches long and 0.048 inch thick.

2.07 PIPE COVERING PROTECTION SADDLES

A. Manufacturers:

1. Anvil International, Inc.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. nVent Electric plc; CADDY.
5. PHD Manufacturing, Inc.

B. Description: MSS SP-58, Type 39A and Type 39B, for suspension of insulated hot pipe where heat losses are to be kept to a minimum.

1. Saddles shall match insulation thickness.
2. Saddle length: 12 inches.
3. Furnish with center rib for pipe sized NPS 12 and larger.

2.08 THERMAL-HANGER SHIELDS

A. Manufacturers:

1. American Mechanical Insulation Sales Inc. (AMIS).
2. B-Line by Eaton.
3. nVent Electric plc; CADDY.
4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

B. Description: Manufactured assembly consisting of insulation insert encased in 360 degree sheet metal shield.

1. Minimum Compressive Strength of Insert Material:
   a. 100-psig- for sizes smaller than NPS 6.
   b. 600-psig- for sizes NPS 6 and larger.

C. Insulation-Insert Material for Cold Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

F. Include carbon steel ASTM A36 load distribution plates as required by load, pipe movement, hanger style, and hanger spacing.

G. Thermal-Hanger Shields for Flexible Foamed Elastomeric Insulated Piping:

1. Manufacturer:
    a. B-Line by Eaton/Armacell; Armafix IPH.
    b. Aeroflex USA, Inc.; Aerofix-U.
    c. ZSi-Foster, Inc.; Cush-A-Therm.
2. Insulation-Insert Material for Copper Piping with Flexible Foamed Elastomeric Insulation: Use the following:
    a. Flexible foamed elastomeric, ASTM 534, Type I-Tubular Grade 1 with PUR/PIP support inserts.

H. Thermal-Hanger Shields for Small Diameter Piping:

1. Manufacturer:
    a. Hydra-Zorb Company; Klo-Shure Insulation Couplings.
2. Insulation-Insert Material for Small Diameter Piping with Flexible Foamed Elastomeric or Glass Fiber Insulation: Use the following:
    a. Rigid Hytrel thermoplastic insulation coupling designed for use with pipe or tube NPS 4 and smaller, and insulation from 3/8 inch to 1-1/2 inch thick.

2.09 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
    a. B-Line by Eaton.
    b. Empire Industries, Inc.
    c. Hilti, Inc.
    d. ITW Ramset/Red Head.
    e. MKT Fastening, LLC.
    f. Powers Fasteners.

B. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.

1. Manufacturers:
    a. Hilti, Inc.
    b. ITW Ramset/Red Head.
    c. MKT Fastening, LLC.
    d. Powers Fasteners.
2. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
3. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
4. Washer and Nut: Zinc-coated steel.

C. Threaded Inserts: Galvanized malleable iron or galvanized steel for 3/4 inch bolts.

1. Manufacturers:

a. Superior Concrete Accessories; Threaded Insert.

b. Dayton Sure-Grip and Shore Co.

c. Richmond Screw Anchor Co.

D. Slotted Inserts: Continuous galvanized steel with temporary slot fillers and complete with nuts, studs, washers and the like, for 3/4 inch bolts.

1. Manufacturers:

a. B-Line by Eaton; B22-I Continuous Concrete Insert.

b. Hilti, Inc.; CIS13812/PG.

c. Hohman and Barnard, Inc.

d. Richmond Screw Anchor Co.

e. Unistrut; a part of Atkore International; P-3200 Continuous Insert.

2.10 ROOF MOUNTED PIPING SUPPORTS

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Low, Fixed-Height, Single-Base Stand: Assembly of base and horizontal member, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

a. B-Line by Eaton; Dura-Blok.

b. Eco Support Products.

c. MIFAB, Inc.; C-Port.

d. MIRO Industries; Conduit and Condensate Supports.

e. nVent Electric plc; CADDY.

f. Portable Pipe Hangers.

2. Base: Plastic, stainless steel, or recycled rubber.

3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.

C. Low, Adjustable-Height, Single-Base Roller Stand: Assembly of base and horizontal roller, for roof installation without membrane penetration.

1. Manufacturers:

a. B-Line by Eaton; Dura-Blok.

b. Eco Support Products.

c. MIFAB, Inc.; C-Port.

d. MIRO Industries; Gas and Mechanical Supports.

e. nVent Electric plc; CADDY.

f. Portable Pipe Hangers.

2. Base: Plastic, stainless steel, or recycled rubber.

3. Horizontal Member: Cadmium-plated-steel rod and corrosion resistant roller designed for use with standard accessories.

4. Vertical Members: Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575 with cadmium plated nuts and washers. Rod continuously threaded.

2.11 ROOF MOUNTED EQUIPMENT SUPPORTS

A. Equipment Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted equipment.

B. Non-Penetrating Equipment Supports: Assembly of two or more bases and horizontal members, for roof installation without membrane penetration.

1. Manufacturers:

a. B-Line by Eaton; Dura-Blok.

b. Eco Support Products.

c. MIFAB, Inc.; C-Port.

d. MIRO Industries; HD and LD Mechanical Unit Supports.

e. nVent Electric plc; CADDY.

f. Portable Pipe Hangers.

2. Base: Plastic, stainless steel, or recycled rubber.

3. Horizontal Member: Cadmium-plated-steel, galvanized-steel, or stainless steel strut, and planking; designed for use with standard strut clamps, all-thread rood, and accessories.

C. Roof Rail-Type Equipment Stands: Welded 18 gage galvanized steel shell, base plate and counter flashing. Factory installed chemically treated wood nailer. Fully mitered end sections. Internal bulkhead reinforcement.

1. Roof Rail Type Supports: Coordinate installation and type with Architectural Trades. Top shall be level and extend a minimum of 10 inches above top of roof insulation.

a. Manufacturers:

1) Pate.

2) Thybar; TEMS Series.

3) Roof Products and Systems.

4) Greenheck.

5) Creative Metals.

2.12 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.13 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT APPLICATIONS

A. Refer to application schedules on the Drawings.

B. For insulated pipe, oversize hanger elements to accommodate insulation thickness.

C. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

D. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.

E. Use hangers and supports with galvanized, metallic coatings for outdoor applications or where exposed to outdoor conditions.

F. Use hangers and supports with plastic coating, or galvanized metallic coatings for applications in corrosive atmospheres.

G. Use metal framing, with plastic coating, or galvanized metallic coatings for metal framing in corrosive atmospheres.

H. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

I. Use padded hangers for piping that is subject to scratching.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. MSS Type 8 or spring type to meet system requirements.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Concrete Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Anchor Devices, Concrete and Masonry: in accordance with Group I, Group II, Type 2, Class 2, Style 1 and Style 2, Group III and Group VIII or FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry, unless otherwise approved by the Architect. Powder actuated anchoring devices shall not be used to support any mechanical systems components.

2. Inserts, Concrete: TYPE 18 or 19. When applied to loads equivalent to piping in sizes NPS 2 and larger, and where otherwise required by imposed loads, a one foot length of 1/2 inch reinforcing rod shall be inserted and wired through wing slots. Proprietary type continuous inserts may be proposed and shall be submitted for approval.

3. Use mechanical-expansion anchors where required in concrete construction.

4. Use chemical fasteners where required in concrete construction.

M. Steel Frame Structure Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Beam Clamps:

a. Center Loading: TYPE 21, 28, 29 and 30, unless otherwise indicated. Type 27 shall be allowed to support single pipes NPS 6 size or smaller only.

b. "C" Clamps: Type 19, 20 or 23, for supporting single pipes NPS 2-1/2 size or smaller only. Use of "C" clamps, or beam clamps of "C" pattern, or any modification thereof, is prohibited for supporting multiple pipes or pipes larger than NPS 2-1/2.

N. Hanger-Rod Attachments for Wood Construction: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. All Steel Ceiling Plates: UL listed and suitable for attachment to wood beams. For pipe sizes NPS 1/2 to NPS 2. Install in accordance with manufacturer’s instructions to maintain listing.

2. Threaded Side Beam Brackets: UL listed and FMG approved, suitable for attachment to wood beams. For pipe sizes NPS 2 to NPS 4. Install in accordance with manufacturer’s instructions to maintain listing.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Use spring supports and sway braces TYPES 48, 49, 50, 51, 52, 53, 54, 55 or 56. For specific points:

a. Provide spring supports at point of support where vertical movement will occur.

b. For light loads and vertical movement less than 1/4 inch, TYPES 48 or 49 spring cushion supports.

c. For vertical movements in excess of 1/4 inch but less than 1/2 inch, TYPES 51, 52 or 53 variable spring supports shall be used, loaded to not more than 75 percent of published load rating.

d. For vertical movements of 1/2 inch and more, TYPES 54, 55 and 56 constant support spring hangers.

e. Sway braces; TYPE 50.

f. Variable spring hangers in accordance with referenced MSS Standards with "medium" allowable load change.

P. Comply with MSS SP-58 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.02 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structural frame.

B. Provide necessary piping and equipment supporting elements including: building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, other pipe, duct or equipment.

C. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohm meter to ensure proper isolation of dissimilar materials. Test shall be observed by the Owner's Representative and/or Architect.

D. Use copper plated or plastic coated supporting element in contact with copper tubing or glass piping.

E. File and paint cut ends and shop or field prime paint supporting element components.

F. Hang piping parallel with the lines of the building, unless otherwise indicated. Route piping in an orderly manner and maintain gradient. Space piping and components so a threaded pipe fitting may be removed between adjacent pipes and so there will be not less than 1/2 inch of clear space between finished surfaces and piping. Arrange hangers on adjacent parallel service lines in line with each other.

G. Flange loads on connected equipment shall not exceed 75 percent of maximum allowed by equipment manufacturer. Flange loads in liquid containing systems shall be checked in the presence of the Architect when piping is full of liquid. No flange load is allowed on pumps, vibration isolated equipment or flexible connectors.

H. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.

I. Incorporate pipe anchors into piping systems to maintain permanent pipe positions. Install alignment guides for the piping adjacent to and on each side of pipe expansion loops and expansion joints to maintain alignment.

J. Where necessary, brace piping and supports against reaction, sway and vibration.

K. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.

L. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.

M. Install hangers and supports for piping at intervals specified, at locations not more than 3 feet from the ends of each runout, not more than 3 feet from connections to equipment, and not over 25 percent of specified interval from each change in direction of piping and for concentrated loads such as valves, etc.

N. Base the load rating for pipe support elements on loads imposed by insulated weight of pipe filled with water. The span deflection shall not exceed slope gradient of pipe.

O. If structural steel, roofs, or tunnels will allow support spacing greater than that shown above, Contractor shall submit proposed support system along with structural calculations documenting the allowance of such spacing, in accordance with ANSI, B31.1, and MSS Guidelines.

P. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Support vertical risers at each floor penetration for piping in shafts or chases. Guide for lateral stability. Fit horizontal piping connected to moving risers with two spring supports connected adjacent to riser, spaced according to required hanger spacing.

Q. For risers at temperatures of 100 deg F or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.

R. After the piping systems have been installed, tested and placed in satisfactory operation, firmly tighten hanger rod nut and jam nut and upset threads to prevent movement of fasteners.

S. Attach pipe anchors and pipe alignment guides to the building structure where indicated. If not indicated, the method used is optional to the Contractor, subject to approval by the Architect. In the case of structural steel, make attachment by clamping in accordance with the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Building.

T. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.

U. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.

V. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.

W. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.

X. Building structure shall not be reinforced except as approved by the Architect in writing.

Y. Use approved cast-in-place inserts or built-in anchors for attachment to concrete structure. Size inserts and anchors for the total applied load with a safety factor in accordance with applicable codes but in no case less than 5. Coordinate installation of all imbedded items in accordance with manufacturer's instructions. Position anchorage and imbedded items as indicated and/or where required and support against displacement during placing of concrete. Cutting or repositioning of concrete beam or girder or reinforcing steel to accommodate inserts will not be allowed. Provide removable closures in imbedded device openings to prevent entry of concrete.

Z. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.

AA. Use cast-in-place inserts in concrete beams and girders. Drilled anchors/wedge type inserts shall be used on vertical surfaces only. Coordinate with structural engineer.

BB. Attach piping supports to the side of concrete beams and concrete joist. Provide supplementary support steel as required. Cast-in-place or drilled anchors will not be permitted in the bottom of concrete beams and concrete joist.

CC. Attach piping supports to the side of concrete beams or concrete joist. Where intermediate hangers are required to meet the hanger spacing schedule, the Contractor may propose attachment of intermediate pipe supports to the bottom of the concrete slab pending submittal of a satisfactory pull out test. The Contractor shall submit pull out test criteria, pull out test results, proposed hanger detail and hanger point loads to the Architect for written approval.

DD. Trapeze Pipe Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

EE. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

FF. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

GG. Roof-Mounting Pipe and Equipment Stand Installation:

1. Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb or Rail Mounting Type Stands: Assemble components or fabricate stand and mount on permanent, stationary roof curb or rail. Refer to Division 07 Section "Roof Accessories" for curb and rail installation.

3. Maintain support manufacturer’s recommended spacing.

HH. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

II. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

JJ. Install hangers and supports to allow controlled thermal 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.

KK. Install lateral bracing with pipe hangers and supports to prevent swaying.

LL. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

MM. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

NN. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

OO. Refer to individual piping sections for hanger spacing and hanger rod sizes.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.05 **ADJUSTING**

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 **PAINTING**

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 20 0533 - ELECTRIC HEAT TRACING

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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:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 22 Section “Heat Tracing for Plumbing” for domestic hot-water-temperature maintenance, and snow and ice melting on roofs, in gutters and downspouts, and rain conductors.
3. Division 23 Section "Radiant-Heating Electric Cables" for surface snow and ice melting.

1.02 SUMMARY

A. Section includes electric heat tracing for piping freeze prevention and flow control.

1.03 PERFORMANCE REQUIREMENTS

A. Pipe Heat Tracing: Select electric heat tracing cable capable of providing freeze protection and flow control with outside temperature at minus 10 deg F.

1.04 SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Delegated-Design Submittal:

1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

C. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.

2. Accurately record actual locations of heating cable, thermostats, and branch circuit connections.

3. Include diagrams for power, signal, and control wiring.

D. Field quality-control reports.

E. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1. Include description of operating controls.

2. Include repair methods and parts list of components.

1.05 **COORDINATION**

A. Coordinate with installation of piping insulation.

PART 2 PRODUCTS

2.01 **SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES**

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

1. Thermon Americas Inc.; FLX Self-Regulating Heating Cable.

2. Raychem; nVent Electric plc; XLTrace.

3. Delta-Therm Corporation; IN Series.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of No. 16 AWG, parallel, nickel-coated copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL acceptable to authorities having jurisdiction, and marked for intended location and application.

I. Capacities and Characteristics:

1. Maximum Heat Output: W/ft. as recommended by manufacturer.

2. Piping Diameter: As indicated on the Drawings.

3. Number of Parallel Cables: As recommended by manufacturer.

4. Electrical Characteristics for Single-Circuit Connection: Coordinate electrical system requirements with Division 26.

J. Electrical Power System Characteristics: As scheduled on the Drawings.

2.02 **CONTROLS**

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

1. Thermon Americas Inc.
2. Raychem; nVent Electric plc.
3. Delta-Therm Corporation.

B. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.03 **ACCESSORIES**

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Self-adhesive labels with legend “ELECTRIC HEAT TRACING.” Refer to Division 20 Section "Mechanical Identification" for additional requirements

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION**

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.

3. Install insulation over piping with electric cables according to Division 20 Section "Mechanical Insulation."

4. Install warning labels at 10 foot intervals, or install continuous warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

3.03 **CONNECTIONS**

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.04 **FIELD QUALITY CONTROL**

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

2. Test cables for electrical continuity and insulation integrity before energizing using 2500 Vdc megohmmeter (megger).

3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Remove and replace damaged heat-tracing cables.

E. Prepare test and inspection reports.

3.05 **PROTECTION**

A. Protect installed heating cables, including non-heating leads, from damage during construction.

END OF SECTION

SECTION 20 0547 - MECHANICAL VIBRATION CONTROLS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.02 SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

C. Welding certificates.

1.03 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

1.04 **COORDINATION**

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of these items is specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.01 **VIBRATION ISOLATION EQUIPMENT BASES**

A. **Type A**: Direct Isolator Attachment

1. Unit to be isolated is so constructed that vibration isolators of the type specified may be directly attached, provided that the edge deflection of the isolated unit base over unsupported span between mountings does not exceed specified or manufacturer's limits. If units to be isolated will not meet required deflection provisions, Type B bases shall be provided.

B. **Type B**: Factory-fabricated, welded, structural-steel bases or rails.

1. Structural Steel Bases:

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WF or a comparable product by one of the following:

1) Amber/Booth; a VMC Group Company.

2) Kinetics Noise Control, Inc.

3) Korfund Dynamics; a VMC Group Company.

4) Vibration Eliminator Co., Inc.

5) Vibration Isolation Co., Inc. (Pump Bases Only)

6) Vibration Mountings & Controls; a VMC Group Company.

7) Vibro-Acoustics.

b. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2. Structural-Steel Rails:

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ICS or a comparable product by one of the following:

1) Amber/Booth; a VMC Group Company.

2) Kinetics Noise Control, Inc.

3) Korfund Dynamics; a VMC Group Company.

4) Vibration Eliminator Co., Inc.

5) Vibration Isolation Co., Inc. (Pump Bases Only)

6) Vibration Mountings & Controls; a VMC Group Company.

7) Vibro-Acoustics.

b. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. **Type C** Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type BMK/KSL or a comparable product by one of the following:

a. Amber/Booth; a VMC Group Company.

b. Kinetics Noise Control, Inc.

c. Korfund Dynamics; a VMC Group Company.

d. Vibration Eliminator Co., Inc.

e. Vibration Isolation Co., Inc. (Pump Bases Only)

f. Vibration Mountings & Controls; a VMC Group Company.

g. Vibro-Acoustics.

2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

D. **Type D** Curb Mounted Aluminum Bases:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type CMAB or a comparable product by one of the following:

a. Kinetics Noise Control, Inc.

b. ThyCurb/Thybar.

c. Vibro-Acoustics.

d. Vib-Iso.

2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.

3. Upper Frame: Corrosion resistant extruded aluminum. Upper frame shall overlap lower frame for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.

4. Lower Frame: Corrosion resistant extruded aluminum. Lower framed shall overlap roof curb for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
5. Safety Stops: Neoprene, mounted in corners of lower frame for extreme wind conditions and mild seismic disturbances under normal conditions.
6. Isolators: Cadmium plated free-standing springs with positive spring retainer and flexible ties.
7. Splicing Kit: Required for bases shipped in multiple pieces.
8. Weatherseal: Flexible frictionless EPDM.
9. Static Deflection: Nominal 1 inch.

E. **Type E** Rooftop Spring Curb:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type RSC or a comparable product by one of the following:
   a. Kinetics Noise Control, Inc.
   b. ThyCurb/Thybar.
   c. Vibro-Acoustics.
2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment; and to withstand wind forces as required by local codes.
3. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
4. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
   a. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with restraint.
      1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
      2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
      3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
      4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
      5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   b. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1) Material: Bridge-bearing neoprene, complying with AASHTO M 251.

2) Durometer Rating: 40.

5. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

6. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

7. Sound Isolation: Within perimeter of roof curb rails and as detailed on the Drawings:

   a. Two layers of 2-inch thick board insulation, minimum 3-lb/cu. ft. density, glass fibers bonded with a thermosetting resin. Comply with ASTM C 612 Type IA or Type IB.

   b. Two layers of 5/8-inch thick water-resistant gypsum core wall panel surfaced with paper on front, back, and long edges. Comply with ASTM C 1396.

   c. One layer of 6-inch thick fiberglass blanket insulation.

8. Static Deflection: Nominal 1 inch, 2 inches, or 3 inches.

2.02 **VIBRATION ISOLATORS**

A. **Type 1a** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type W, Super W, WSW, and WSWSW or comparable products by one of the following:

   a. Amber/Booth; a VMC Group Company.

   b. Kinetics Noise Control, Inc.

   c. Korfund Dynamics; a VMC Group Company.

   d. Vibration Eliminator Co., Inc.

   e. Vibration Mountings & Controls; a VMC Group Company.

   f. Vibro-Acoustics.

2. Material: Standard neoprene for indoor applications.

3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.

B. **Type 1b** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, single layer, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and 1/4 inch steel load bearing plate. Factory cut to sizes that match requirements of supported equipment.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type Super WMSW and MBSW or a comparable product by one of the following:

   a. Amber/Booth; a VMC Group Company.

   b. Kinetics Noise Control, Inc.

   c. Korfund Dynamics; a VMC Group Company.

   d. Vibration Eliminator Co., Inc.

e. Vibration Mountings & Controls; a VMC Group Company.

f. Vibro-Acoustics.

2. Material: Standard neoprene for indoor applications.

3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.

C. **Type 2** Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ND or a comparable product by one of the following:

a. Amber/Booth; a VMC Group Company.

b. Kinetics Noise Control, Inc.

c. Korfund Dynamics; a VMC Group Company.

d. Vibration Eliminator Co., Inc.

e. Vibration Mountings & Controls; a VMC Group Company.

f. Vibro-Acoustics.

2. Durometer Rating: Selected for maximum possible static deflection with the loading of each piece of equipment.

3. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.

4. Neoprene: Bridge-bearing neoprene as defined by AASHTO.

D. **Type 3** Spring Isolators: Freestanding, open-spring isolators.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type SLF or a comparable product by one of the following:

a. Amber/Booth; a VMC Group Company.

b. Kinetics Noise Control, Inc.

c. Korfund Dynamics; a VMC Group Company.

d. Vibration Eliminator Co., Inc.

e. Vibration Mountings & Controls; a VMC Group Company.

f. Vibro-Acoustics.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. **Type 4** Restrained Spring Isolators: Restrained single and multiple spring mounts.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Types SLR and SLRS or comparable products by one of the following:
    a. Amber/Booth; a VMC Group Company.
    b. Kinetics Noise Control, Inc.
    c. Korfund Dynamics; a VMC Group Company.
    d. Vibration Eliminator Co., Inc.
    e. Vibration Mountings & Controls; a VMC Group Company.
    f. Vibro-Acoustics.
2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. **Type 5** Thrust Restraints

1. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression or tension as required, and with a load stop. Include rod and angle-iron brackets with back-up plates for attaching to equipment and ductwork.
    a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WBI for fan inlet connections, and Type WBD for fan outlet connections, or comparable products by one of the following:
        1) Amber/Booth; a VMC Group Company.
        2) Kinetics Noise Control, Inc.
        3) Korfund Dynamics; a VMC Group Company.
        4) Vibration Eliminator Co., Inc.
        5) Vibration Mountings & Controls; a VMC Group Company.
        6) Vibro-Acoustics.
    b. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
    c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    e. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
    f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
    g. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

h. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.03 **VIBRATION ISOLATION HANGERS**

A. **Type 8a** Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type 30N or a comparable product by one of the following:

a. Amber/Booth; a VMC Group Company.

b. Kinetics Noise Control, Inc.

c. Korfund Dynamics; a VMC Group Company.

d. Vibration Eliminator Co., Inc.

e. Vibration Mountings & Controls; a VMC Group Company.

f. Vibro-Acoustics.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

B. **Type 8b** Spring Hangers with Vertical-Limit Stop: Precompressed combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type PC30N or a comparable product by one of the following:

a. Amber/Booth; a VMC Group Company.

b. Kinetics Noise Control, Inc.

c. Korfund Dynamics; a VMC Group Company.

d. Vibration Eliminator Co., Inc.

e. Vibration Mountings & Controls; a VMC Group Company.

f. Vibro-Acoustics.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

2.04 **FACTORY FINISHES**

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION**

A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 07 Section "Roof Accessories."

B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

3.03 **APPLICATION**

A. Refer to Vibration Isolator Application Schedule on the drawings for isolator application and minimum deflection.

3.04 **CONNECTIONS**

A. Provide flexible electrical connections in the form of large radius, 360 degree loop of flexible conduit for all vibrating isolated equipment. Any cooling water lines, compressed air, or other piping services (except inlet and outlet water connections for pumps, chillers or cooling tower) shall be made with 360 degree loops of reinforced neoprene hose, which are attached using nipples of appropriate gender. All service connections made with neoprene hose shall have shut-off valves between the hose and the supply service.

B. Vibration isolate piping connected to vibration isolated equipment using Type 8a or 8b spring hangers, and with distance to be isolated as scheduled on the Drawings. Maximum spacing between isolators same as maximum distance between pipe hangers and supports.

C. Vibration isolate ductwork connected to air handling units, return air fans, and vibration isolated equipment using Type 8a or 8b spring hangers, and in accordance with isolation distances scheduled on the Drawings.

3.05 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.

1. Cast-in-place concrete materials and placement requirements are specified in Division 03.

B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.06 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. Isolator deflection.

2. Snubber minimum clearances.

3.07 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's written recommendations.

3.08 CLEANING

A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

SECTION 20 0553 - MECHANICAL IDENTIFICATION

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”

1.02 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in Maintenance Manuals.

1.03 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME (ANSI) A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.04 **COORDINATION**

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Seton.
2. Brady.
3. EMED.
4. Craftmark.
5. Brimar Industries, Inc.
6. Marking Services Inc. (MSI).
7. Kolbi Pipe Marker Co.

2.02 **EQUIPMENT IDENTIFICATION DEVICES**

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:
   a. Manufacturer, product name, model number, and serial number.
   b. Capacity, operating and power characteristics, and essential data.
   c. Labels of tested compliances.
2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.
2. Data:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless

otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
3. Thickness: Minimum 1/16 inch, unless otherwise indicated.
4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.03 **PIPING IDENTIFICATION DEVICES**

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME (ANSI) A13.1, unless otherwise indicated.
2. Type and Size of Letters: Comply with ANSI A13.1, unless otherwise indicated.
3. Legends: Spelled out in full or commonly used and accepted abbreviations.
4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

F. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4mil thick, manufactured for direct burial service.

G. Detectable Underground Pipe Markers: Continuously printed plastic ribbon tape with detectable aluminum core and with colors meeting APWA requirements, not less than 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.04 **DUCT IDENTIFICATION DEVICES**

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

B. Duct Markers: Vinyl, 2-inch minimum character height, with permanent pressure sensitive adhesive. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust).

2.05 **VALVE TAGS**

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.

2. Valve-Tag Fasteners: Brass wire-link chain or beaded chain.

2.06 **VALVE SCHEDULES**

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.

2. Frame: Finished hardwood or extruded aluminum.

3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.07 **WARNING TAGS**

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 **APPLICATIONS, GENERAL**

A. Products specified are for applications referenced in other Division 20, 21, 22, and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.02 **EQUIPMENT IDENTIFICATION**

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
4. Fans, blowers, primary balancing dampers, and mixing boxes.
5. Packaged HVAC central-station and zone-type units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
   a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
   b. Fire department hose valves and hose stations.
   c. Meters, gages, thermometers, and similar units.
   d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
   e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
   f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
   g. Fans, blowers, primary balancing dampers, and mixing boxes.
   h. Packaged HVAC central-station and zone-type units.
   i. Tanks and pressure vessels.
   j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with equipment markers in the following color codes:
   a. Green: For cooling equipment and components.
   b. Yellow: For heating equipment and components.
   c. Orange: For combination cooling and heating equipment and components.
   d. Brown: For energy-reclamation equipment and components.
2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

4. Include signs for the following general categories of equipment:
    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
    e. Fans, blowers, primary balancing dampers, and mixing boxes.
    f. Packaged HVAC central-station and zone-type units.
    g. Tanks and pressure vessels.
    h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

D. Install access panel markers with screws on equipment access panels.

E. Area Served: Equipment serving different areas of a building other than where the equipment is installed shall be permanently marked in a manner that, in addition to identifying the equipment as specified in this Section, also identifies the area it serves.

3.03 **PIPING IDENTIFICATION**

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, minimum 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, minimum 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

C. Underground Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.

3.04 **DUCT IDENTIFICATION**

A. Install engraved duct markers with permanent adhesive on air ducts in the following color codes:

1. Refer to Schedule.

2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Identify ductwork with vinyl markers and flow direction arrows.

C. Locate markers at air handling units, each side of floor and wall penetrations, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.05 **VALVE-TAG INSTALLATION**

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:

a. Cold Water: Minimum 1-1/2 inches, round or square.

b. Hot Water: Minimum 1-1/2 inches, round or square.

c. Fire Protection: Minimum 1-1/2 inches, round or square.

d. Gas: Minimum 1-1/2 inches, round or square.

e. Steam: Minimum 1-1/2 inches, round or square.

3.06 **VALVE-SCHEDULE INSTALLATION**

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.07 **HAZARDOUS MATERIAL IDENTIFICATION DEVICES**

A. Mount to wall or door of room containing hazard. Indicate classification of refrigerant or other hazard.

3.08 **WARNING-TAG INSTALLATION**

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.09 **ADJUSTING**

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.10 **CLEANING**

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

3.11 **SCHEDULES**

A. Paint colors are listed here for reference only. Painting is specified under Division 9.

PIPE LABELING AND COLOR CODING

Pipe System Label	Drawing Abbrev.	Labels	Piping
Sanitary Sewer	SAN	White on Green	Dark Brown
Sanitary Vent	V	White on Green	Dark Brown
Rain Conductor	RC	White on Green	Dark Brown
Acid Waste	AW	Black on Yellow	Black
Acid Vent	AV	Black on Yellow	Black
Domestic Cold Water	CW	White on Green	Light Green
High Pressure Domestic Cold Water	HPCW	White on Green	Light Green
Non-Potable Cold Water	NPCW	Black on Yellow	
Domestic Hot Water	HW	Black on Yellow	Dark Green
High Pressure Domestic Hot Water	HPHW	Black on Yellow	Dark Green
High Pressure Domestic Hot Water Return	HPHWR	Black on Yellow	Dark Green
Domestic Hot Water Return	HWR	Black on Yellow	Dark Green
Soft Cold Water	SCW	White on Green	Light Green
Soft Hot Water	SHW	White on Green	Dark Green
Soft Hot Water Return	SHWR	White on Green	Dark Green
Natural Gas	G	Black on Yellow	Yellow
Fuel Oil Supply	FOS	Black on Yellow	Yellow
Fuel Oil Return	FOR	Black on Yellow	Yellow
Compressed Air (90psig)	A(90psig)	Black on Yellow	Dark Blue
Compressed Air (25psig)	A	White on Green	Dark Blue
Laboratory Vacuum	LVAC	Black on Yellow	Unpainted
Carbon Dioxide	CO_2	Black on Yellow	Unpainted
High Purity Water	DI	White on Green	White
Hot Water Htg. Supply	HWHS	Black on Yellow	Dark Blue
Hot Water Htg. Return	HWHR	Black on Yellow	Dark Blue
Terminal Unit Heating Sup.	THS	Black on Yellow	Dark Blue
Terminal Unit Heating Ret.	THR	Black on Yellow	Dark Blue
Animal Heating Supply	AHS	Black on Yellow	Dark Blue
Animal Heating Return	AHR	Black on Yellow	Dark Blue
Energy Recovery Loop Sup.	ERLS	Black on Yellow	Dark Blue
Energy Recovery Loop Ret.	ERLR	Black on Yellow	Dark Blue
Chilled Water Supply	CHWS	White on Green	Light Blue
Chilled Water Return	CHWR	White on Green	Light Blue
Condenser Water Supply	CWS	White on Green	Light Green
Condenser Water Return	CWR	White on Green	Light Green
Process Cooling Water Sup.	PCWS	White on Green	Light Green
Process Cooling Water Ret.	PCWR	White on Green	Light Green
Refrigerant Liquid	RL	Black on Yellow	
Refrigerant Suction	RS	Black on Yellow	
Steam Condensate	LPC	Black on Yellow	Aluminum
Medium Pressure Steam Condensate	MPC	Black on Yellow	Aluminum
High Pressure Steam Condensate	HPC	Black on Yellow	Aluminum
Pumped Steam Condensate	PC	Black on Yellow	Aluminum
Medium Pressure Steam (60 psig)	MPS	Black on Yellow	Aluminum
High Pressure Steam,	HPS	Black on Yellow	Aluminum
Low Pressure Steam (5 psig)	LPS	Black on Yellow	Aluminum
Fire Protection	FP	White on Red	Bright Red

SHEET METAL WORK

Service	Abbrev.	Labels	Ductwork
Air Conditioning Supply	Supply Air	White on Green	White
Air Conditioning Return	Return Air	White on Green	White
Exhaust Systems	Exhaust Air	Black on Yellow	Green
Outside Air Intake	Outside Air	White on Green	White
Mixed Air	Mixed Air	White on Green	White

END OF SECTION

SECTION 20 0700 - MECHANICAL INSULATION

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Materials and Methods.”
3. Division 20 Section “Hanger and Supports” for thermal hanger shield inserts.
4. Division 22 Section “Plumbing Fixtures: for protective shielding guards.
5. Division 22 Section “Medical Plumbing Fixtures” for protective shielding guards.
6. Division 23 Section "Metal Ducts" for duct liners.

1.02 **SUMMARY**

A. This Section includes mechanical insulation for pipe, duct, and equipment.

1.03 **DEFINITIONS**

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. PSK: Polypropylene, scrim, kraft paper.

D. PVC: Polyvinyl Chloride.

E. SSL: Self-sealing lap.

1.04 **INDOOR PIPING INSULATION SYSTEMS DESCRIPTION**

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

B. Sanitary Waste Piping Where Heat Tracing Is Installed, All Pipe Sizes: Glass-Fiber Pipe Insulation, Type I: 1-1/2 inches thick.

1.05 **OUTDOOR, ABOVEGROUND PIPING INSULATION SYSTEMS DESCRIPTION**

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

B. Sanitary or Storm Piping Where Heat Tracing Is Installed, All Pipe Sizes: Glass-Fiber Pipe Insulation, Type I: 2 inches thick.

1.06 **INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION**

A. Acceptable indoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.07 **ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION**

A. Acceptable outdoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.08 **EQUIPMENT INSULATION SYSTEMS DESCRIPTION**

A. Acceptable equipment insulation materials and thicknesses are scheduled on the Drawings.

1.09 **FIELD-APPLIED JACKETING SYSTEMS DESCRIPTION**

A. Acceptable field-applied jacketing materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe specialty.

1.10 **SUBMITTALS**

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1. ESR Report: For fire-rated grease duct insulation.

B. Shop Drawings: Show details for the following:

1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Attachment and covering of heat tracing inside insulation.
3. Insulation application at pipe expansion joints for each type of insulation.
4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Removable insulation at piping specialties, equipment connections, and access panels.
6. Application of field-applied jackets.
7. Application at linkages of control devices.
8. Field application for each equipment type
9. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.11 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Ductwork Maximum Temperature Limits: Based on ASTM C 411 test procedures.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Prior to installation, protect insulation from exposure to water and from physical damage. Prior to installation, store insulation in manufacturer’s original packaging.

1.13 COORDINATION

A. Coordinate size and location of supports, hangers, and pre-insulated pipe shields/supports specified in Division 20 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.14 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS, GENERAL REQUIREMENTS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Adhesives used shall be fire resistant in their dry states and UL listed.

2.02 PIPE INSULATION MATERIALS

A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Aeroflex USA, Inc.; Aerocel Tube and Sheet.
    b. Armacell LLC; AP Armaflex.
    c. IK Insulation Group; K-Flex USA LLC; Insul-Tube and Insul-Sheet.

B. Glass-Fiber, Preformed Pipe Insulation, Type I:

1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Johns Manville; Micro-Lok.
    b. Knauf Insulation; 1000 Pipe Insulation.
    c. Manson Insulation Inc.; Alley-K.
    d. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

2.03 DUCTWORK INSULATION MATERIALS

A. Blanket Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. CertainTeed Corp.; Duct Wrap.
    b. Johns Manville; Microlite EQ.
    c. Knauf Insulation; Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap FSK.
    e. Owens Corning; All-Service Duct Wrap.

B. Board Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. CertainTeed Corp.; Commercial Board.

b. Fibrex Insulations Inc.; FBX.

c. Johns Manville; 800 Series Spin-Glas.

d. Knauf Insulation; Insulation Board.

e. Manson Insulation Inc.; AK Board.

f. Owens Corning; Fiberglas 700 Series.

2.04 EQUIPMENT INSULATION MATERIALS

A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Aeroflex USA, Inc.; Aerocel Tube and Sheet.

b. Armacell LLC; AP Armaflex.

c. IK Insulation Group; K-Flex USA LLC; Insul-Tube and Insul-Sheet.

B. Board Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. CertainTeed Corp.; Commercial Board.

b. Fibrex Insulations Inc.; FBX.

c. Johns Manville; 800 Series Spin-Glas.

d. Knauf Insulation; Insulation Board.

e. Manson Insulation Inc.; AK Board.

f. Owens Corning; Fiberglas 700 Series.

C. Large Diameter Pipe and Tank Insulation: Glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. CertainTeed Corp.; CrimpWrap.

b. Johns Manville; MicroFlex.

c. Knauf Insulation; Pipe and Tank Insulation.

d. Manson Insulation Inc.; AK Flex.

e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.05 FIRE-RATED INSULATION SYSTEMS

A. Grease Duct Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested according to ASTM E2336.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Morgan Thermal Ceramics; FireMaster FastWrap XL and Pyroscat XL.

b. 3M Fire Protection Products; Fire Barrier Duct Wrap 615+.

c. Unifrax Corporation; FyreWrap Max 2.0.

B. Fire-Rated Plenum Wrap: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested, and designed to provide a single-layer, flexible enclosure around combustible items located within fire-rated return air plenums.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Unifrax Corporation; FyreWrap 0.5 Plenum Insulation.

b. 3M Fire Protection Products; Fire Barrier Plenum Wrap 5A+.

c. Morgan Thermal Ceramics; FireMaster PlenumWrap and PlenumWrap+.

2.06 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Insulco, Division of MFS, Inc.; Triple I.

b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Insulco, Division of MFS, Inc.; SmoothKote.

b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.

c. Rock Wool Manufacturing Company; Delta One Shot.

2.07 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Armacell LCC; 520 Adhesive.

b. Foster Products Corporation, H. B. Fuller Company; 85-75.

c. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Childers Products, H.B. Fuller Company; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

e. Mon-Eco Industries, Inc.; 22-25.

f. Vimasco Corporation.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Childers Products, H.B. Fuller Company; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

e. Mon-Eco Industries, Inc.; 22-25.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Dow Chemical Company (The); 739, Dow Silicone.

b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

c. P.I.C. Plastics, Inc.; Welding Adhesive.

d. Red Devil, Inc.; Celulon Ultra Clear.

e. Speedline Corporation; Speedline Vinyl Adhesive.

2.08 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Childers Products, H.B. Fuller Company; CP-35.

b. Foster Products Corporation, H. B. Fuller Company; 30-90.

c. ITW TACC, Division of Illinois Tool Works; CB-50.

d. Marathon Industries, Inc.; 590.

e. Mon-Eco Industries, Inc.; 55-40.

f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Childers Products, H.B. Fuller Company; CP-10.
    b. Foster Products Corporation, H. B. Fuller Company; 35-00.
    c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    d. Marathon Industries, Inc.; 550.
    e. Mon-Eco Industries, Inc.; 55-50.
    f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.09 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Childers Products, H.B. Fuller Company; CP-76-8.
    b. Foster Products Corporation, H. B. Fuller Company; 95-44.
    c. Marathon Industries, Inc.; 405.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Childers Products, H.B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.10 FACTORY-APPLIED JACKETS

A. Insulation systems indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.11 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as specified; roll stock ready for shop or field cutting and forming.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Airex Manufacturing, Inc.; E-Flex Guard.

b. Johns Manville; Zeston and Ceel-Co.

c. P.I.C. Plastics, Inc.; FG Series.

d. Proto PVC Corporation; LoSmoke.

e. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: White.

4. Factory-fabricated tank heads and tank side panels.

C. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C, and including flexible glass fiber insulation inserts.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Airex Manufacturing, Inc.

b. Johns Manville; Zeston and Ceel-Co.

c. P.I.C. Plastics, Inc.; FG Series.

d. Proto PVC Corporation; LoSmoke.

e. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by manufacturer.

3. Color: White.

4. Factory-fabricated fitting covers:

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. PABCO-Childers Metals; ITW Insulation Systems; Metal Jacketing Systems.

b. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.

d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.

e. Factory-Fabricated Fitting Covers:

1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.

3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

a. Sheet and roll stock ready for shop or field sizing factory cut and rolled to size.

b. Material, finish, and thickness are indicated in field-applied jacket systems.

c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.

d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick Polysurlyn.

e. Factory-Fabricated Fitting Covers:

1) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

2) Provide factory fabricated PVC tee covers, flange and union covers, beveled collars and valve covers.

3) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket for Piping: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a fabric reinforced insulation cladding with natural aluminum stucco embossed facing.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. 3M VentureClad; 1579GCW-E.

b. Polyguard; Alumaguard.

F. Self-Adhesive Outdoor Jacket for Ductwork: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. MFM Building Products Corp.; FlexClad-400

b. Polyguard; Alumaguard.

c. 3M VentureClad.

2.12 **TAPES**

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.

1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
    b. Compac Corp.; 104 and 105.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    b. Compac Corp.; 110 and 111.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the products specified.
    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    b. Compac Corp.; 130.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

b. Compac Corp.; 120.

c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.

d. Venture Tape; 3520 CW.

2. Width: 2 inches.

3. Thickness: 3.7 mils.

4. Adhesion: 100 ounces force/inch in width.

5. Elongation: 5 percent.

6. Tensile Strength: 34 lbf/inch in width.

2.13 **SECUREMENTS**

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the products specified.

a. PABCO-Childers Metals; ITW Insulation Systems; Pab-Bands and Fabstraps.

b. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, provide one of the products specified.

1) AGM Industries, Inc.; CWP-1.

2) GEMCO; CD.

3) Midwest Fasteners, Inc.; CD.

4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, provide one of the products specified.

1) AGM Industries, Inc.; CWP-1.

2) GEMCO; Cupped Head Weld Pin.

3) Midwest Fasteners, Inc.; Cupped Head.

4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide one of the products specified.

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.

2) GEMCO; Perforated Base.

3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide one of the products specified.

1) GEMCO; Nylon Hangers.

2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide one of the products specified.

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.

2) GEMCO; Press and Peel.

3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the products specified.

1) AGM Industries, Inc.; RC-150.

2) GEMCO; R-150.

3) Midwest Fasteners, Inc.; WA-150.

4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Manufacturers:

1) GEMCO.

2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers:

a. ACS Industries, Inc.

b. C & F Wire.

c. PABCO-Childers Metals; ITW Insulation Systems.

d. RPR Products, Inc.

2.14 **CORNER ANGLES**

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **PREPARATION**

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 **COMMON INSTALLATION REQUIREMENTS**

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at the 4 o’clock or 8 o’clock position on horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive as recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. For services with surface temperatures below ambient, install a continuous unbroken vapor barrier. Seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install thermal hanger insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover thermal hanger inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at the 4 o'clock or 8 o'clock position on the pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness. Where compression of insulation is possible, fabricate/install insulation per manufacturer's recommendations.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations that Are Not Fire Rated: Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations:

1. Terminate ductwork insulation at angle closure of fire damper sleeves.
2. Install pipe insulation continuously through penetrations of fire-rated walls and partitions.
    a. Firestopping is specified in Division 07 Section “Through-Penetration Firestop Systems.”

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at angle closure of fire damper sleeves.
2. Pipe: Install insulation continuously through floor penetrations.
    a. Seal penetrations through fire-rated assemblies according to Division 07 Section "Through-Penetration Firestop Systems."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever

is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible Elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 FLEXIBLE ELASTOMERIC PIPE INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 GLASS-FIBER AND MINERAL WOOL PIPE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install PVC fitting covers when available.

2. When PVC fitting covers are not available, install preformed pipe insulation to outer diameter of pipe flange:

a. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

b. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with fiberglass or mineral wool blanket insulation as specified for system.

3. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install PVC fitting covers when available.
2. When PVC fitting covers are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install PVC fitting covers when available.
2. When PVC fitting covers are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.08 DUCT AND PLENUM INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.

1. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
2. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
3. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

   d. Do not over compress insulation during installation.

   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Flexible Elastomeric Thermal Insulation Installation for Ducts and Plenums: Install insulation over entire surface of ducts and plenums.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

2. Seal longitudinal seams and end joints.

3. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with strips of same material used to insulate duct and following manufacturer’s installation instructions.

3.09 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

a. Do not weld anchor pins to ASME-labeled pressure vessels.

b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.

d. Do not over compress insulation during installation.

e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

f. Impale insulation over anchor pins and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where self-adhesive jackets are indicated, install according to manufacturer’s instructions and details on the drawings. Overlap seams arranged to shed water.

F. Where sound barrier jackets are indicated, install in accordance with manufacturer’s instructions.

3.11 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, install two layers in strict accordance with manufacturer’s instructions, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors in strict accordance with insulation manufacturer’s to achieve same fire rating as duct.

C. Maintain a copy of insulation manufacturer’s installation instructions on site for Code Official.

D. Where fire-rated plenum wrap system is indicated, secure to system piping to maintain a continuous UL-listed fire rating.

E. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Through-Penetration Firestop Systems."

3.12 **FINISHES**

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system specified in Division 09 painting Sections.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

END OF SECTION

SECTION 21 1110 - FIRE-SUPPRESSION SYSTEM

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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. Provisions of Division 20 Section “Mechanical General Requirements” apply to this Section.

C. Related Sections include the following:

1. Division 10 Section "Fire-Protection Specialties" for cabinets and fire extinguishers.
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section "Hangers and Supports.”
4. Division 28 Section "Fire Alarm" for alarm devices not specified in this Section.
5. Division 33 Section "Water Distribution" for piping outside the building.

1.02 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.

C. PE: Polyethylene plastic.

D. Underground Service-Entrance Piping: Underground service piping below the building.

E. Hose Connection: Valve with threaded outlet matching fire hose coupling thread for attaching fire hose.

F. Hose Station: Hose connection, fire hose rack, and fire hose.

G. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13 and NFPA 14 for obtaining approval from authorities having jurisdiction.

1.03 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.04 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications, for bidding purposes, as follows:
    a. Automobile Parking Areas: Ordinary Hazard, Group 1.
    b. Building Service Areas: Ordinary Hazard, Group 1.
    c. Churches: Light Hazard.

d. Electrical Equipment Rooms: Ordinary Hazard, Group 1.

e. Dry-Cleaners: Ordinary Hazard, Group 2.

f. General Storage Areas: Ordinary Hazard, Group 1.

g. Laundries: Ordinary Hazard, Group 1.

h. Libraries, Except Stack Areas: Light Hazard.

i. Library Stack Areas: Ordinary Hazard, Group 2.

j. Machine Shops: Ordinary Hazard, Group 2.

k. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.

l. Office and Public Areas: Light Hazard.

m. Plastics Processing Areas: Extra Hazard, Group 2.

n. Printing Plants: Extra Hazard, Group 1.

o. Repair Garages: Ordinary Hazard, Group 2.

p. Residential Living Areas: Light Hazard.

q. Restaurant Service Areas: Ordinary Hazard, Group 1.

r. Solvent Cleaning Areas: Extra Hazard, Group 2.

s. Upholstering Plants: Extra Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1950-sq. ft. area.

b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm/sq. ft. over 1500-sq. ft. area.

d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm/sq. ft. over 2500-sq. ft. area.

e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm/sq. ft. over 2500-sq. ft. area.

f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

4. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft.

b. Storage Areas: 130 sq. ft.

c. Mechanical Equipment Rooms: 130 sq. ft.

d. Electrical Equipment Rooms: 130 sq. ft.

e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm for 30 minutes.

b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.

D. Water velocity in the piping system shall not exceed the following:

1. Underground mains: 16 ft./sec.

2. Aboveground mains: 32 ft./sec.

3. Sprinkler branch lines: 24 ft./sec.

1.05 **SUBMITTALS**

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.

2. Compressed air piping.

3. HVAC hydronic piping.

4. Items penetrating finished ceiling include the following:

a. Lighting fixtures.

b. Air outlets and inlets.

E. Qualification Data: For qualified Installer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, the Owner’s insurance underwriter including hydraulic calculations, if applicable.

1. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification number (SIN) or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

G. Welding certificates.

H. Fire-hydrant flow test report.

I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping"

J. Field quality-control reports.

K. Operation and Maintenance Data: For sprinkler specialties to include in operation and maintenance manuals.

1.06 **QUALITY ASSURANCE**

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. The provisions and requirements of the NFPA and the Owner's insurance underwriter constitute mandatory minimum requirements for the work of this Section.

D. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

1.07 **COORDINATION**

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Coordinate with ceiling installer to ensure proper grid type and installation for use with flexible sprinkler drops.

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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **DUCTILE-IRON PIPE AND FITTINGS**

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, pressure class 350, with mechanical-joint bell end and plain end.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, pressure class 350, with push-on-joint bell end and plain end.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Gaskets: AWWA C111, rubber.

C. Encasement for Underground Ductile-Iron Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.03 **STANDARD-WEIGHT BLACK STEEL PIPE AND FITTINGS**

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends, and with factory applied antimicrobial coating on inner wall of pipe.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865.

B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, and with factory applied antimicrobial coating on inner wall of pipe.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll- grooved ends, and with factory applied antimicrobial coating on inner wall of pipe.

1. Grooved-Joint Piping Systems:
   a. Manufacturers:
      1) Anvil International, Inc.; Model 7401.
      2) Tyco Fire Protection Products by Johnson Controls Company; Grinnell G-Fire.
      3) Victaulic Co. of America; Style 005 or 009.
   b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
   c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.04 **STANDARD-WEIGHT GALVANIZED STEEL PIPE AND FITTINGS**

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized, with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1, hot-dip galvanized.
2. Malleable-Iron Threaded Fittings: ASME B16.3, hot-dip galvanized.
3. Gray-Iron Threaded Fittings: ASME B16.4, hot-dip galvanized.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe, hot-dip galvanized. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865, hot-dip galvanized.

B. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized with factory- or field-formed, square-cut-grooved ends.

1. Grooved-Joint Piping Systems:
    a. Manufacturers:
        1) Anvil International, Inc.; Model 7401.
        2) Tyco Fire Protection Products by Johnson Controls Company; Grinnell G-Fire.
        3) Victaulic Co. of America; Style 005 or 009.
    b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
    c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.05 SCHEDULE 10 BLACK STEEL PIPE AND FITTINGS

A. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13 specified wall thickness in NPS 6 to NPS 10, and with factory applied antimicrobial coating on inner wall of pipe.
    1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
    2. Steel Flanges and Flanged Fittings: ASME B16.5.

B. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends, and with factory applied antimicrobial coating on inner wall of pipe.
    1. Grooved-Joint Piping Systems:
        a. Manufacturers:
            1) Anvil International, Inc.; Model 7401.
            2) Tyco Fire Protection Products by Johnson Controls Company; Grinnell G-Fire.
            3) Victaulic Co. of America; Style 005 or 009.
        b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
        c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.06 FLEXIBLE CONNECTORS

A. Flexible connectors shall have materials suitable for system fluid. with 175-psig minimum working-pressure rating. Flexible connectors shall have 300-psig working-pressure rating if fittings are components of high-pressure piping system.
    1. NPS 2 and Smaller: Threaded.
    2. NPS 2-1/2 and Larger: Flanged.
    3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.

B. Manufacturers:

1. Anamet Inc.
2. Flex-Hose Co., Inc.
3. Flexicraft Industries.
4. Hyspan Precision Products, Inc.
5. Metraflex, Inc.

C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.07 BACKFLOW PREVENTION DEVICES

A. Double-Check, Detector-Assembly Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. FEBCO; a Division of Watts Water Technologies, Inc.
   c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
   d. Watts Water Technologies, Inc.; Watts Regulator Co.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1048 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Size and Capacities: As scheduled on the drawings.
6. Body: Cast-iron or ductile-iron, with interior lining complying with AWWA C550 or that is FDA approved.
7. End Connections: Flanged.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
   a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
   b. Bypass: With displacement-type water meter, shutoff valves, and double-check backflow prevention device.

2.08 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 300-psig working-pressure rating if fittings are components of high-pressure piping system.

B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:
   a. Tyco Fire Protection Products by Johnson Controls Company.

b. Fire-End and Croker Corp.

c. Viking Corp.

d. Victaulic Co. of America.

C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Manufacturers:

a. Elkhart Brass Mfg. Co., Inc.

D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Manufacturers:

a. AGF Manufacturing Co.

b. Tyco Fire Protection Products by Johnson Controls Company.

c. G/J Innovations, Inc.

d. Triple R Specialty of Ajax, Inc.

E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Manufacturers:

a. CECA, LLC.

b. Merit.

F. Flexible Sprinkler Drop Fittings:

1. Manufacturers:

a. Victaulic Co. of America; AquaFlex Sprinkler Fittings; AH-2 with AB1 Bracket Assembly.

b. FlexHead Industries, Inc.

2. Description: UL listed and FMG approved flexible hose for connection to sprinkler, and with bracket for connection to commercial ceiling grid.

3. Standard: UL 2443.

4. Pressure Rating: 175 psig minimum; 300 psig if fittings are components of high-pressure piping system.

5. Size: Same as connected piping, for sprinkler.

G. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.09 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.

2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.

3. Manufacturers:
    a. McWane, Inc.; Kennedy Valve Div.
    b. NIBCO.
    c. Crane Co.; Crane Valve Group; Stockham Valves.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3: Ductile-iron body with grooved ends.
4. Manufacturers:
    a. NIBCO.
    b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.
1. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
    a. Manufacturers:
        1) McWane, Inc.; Kennedy Valve Div.
        2) Mueller Company.
        3) NIBCO.
        4) Tyco Fire Protection Products by Johnson Controls Company.
        5) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
    a. Crane Co.; Crane Valve Group; Crane Valves.
    b. Crane Co.; Crane Valve Group; Jenkins Valves.
    c. Tyco Fire Protection Products by Johnson Controls.
    d. Hammond Valve.
    e. McWane, Inc.; Kennedy Valve Div.
    f. Mueller Company.
    g. NIBCO.
    h. Crane Co.; Crane Valve Group; Stockham Valves.
    i. Victaulic Co. of America.
    j. Watts Water Technologies, Inc.; Watts Regulator Co.

F. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.
    a. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
   a. Manufacturers:
      1) McWane, Inc.; Clow Valve Co.
      2) Crane Co.; Crane Valve Group; Crane Valves.
      3) Crane Co.; Crane Valve Group; Jenkins Valves.
      4) Hammond Valve.
      5) Milwaukee Valve Company.
      6) Mueller Company.
      7) NIBCO.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
   1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch.
   2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
      a. Manufacturers:
         1) Milwaukee Valve Company.
         2) NIBCO.
         3) Victaulic Co. of America.
   3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
      a. Manufacturers:
         1) Tyco Fire Protection Products by Johnson Controls.
         2) McWane, Inc.; Kennedy Valve Div.
         3) Milwaukee Valve Company.
         4) NIBCO.
         5) Victaulic Co. of America.

2.10 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.11 ALARM CHECK VALVES

A. General Requirements:

1. Standard: UL listed or FMG approved.
2. Pressure Rating:
   a. Standard-Pressure Valves: 175 psig minimum.
   b. High-Pressure Valves: 300 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Manufacturers:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire Protection Products by Johnson Controls Company.
3. Viking Corp.
4. Victaulic Co. of America.

C. Description: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.

1. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
2. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

2.12 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have 300-psig pressure rating if sprinklers are components of high-pressure piping system.

B. Manufacturers:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire Protection Products by Johnson Controls Company.
3. Victaulic Co. of America.
4. Viking Corp.

C. Automatic Sprinklers:

1. With heat-responsive glass bulb element complying with the following:
   a. UL 199, for nonresidential applications.
   b. UL 1767, for early-suppression, fast-response applications.
   c. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
   d. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for 165 deg F Ordinary temperature classification rating, unless otherwise indicated or required by application.

E. Sprinkler types, features, and options as follows:

1. Concealed ceiling sprinklers, including cover plate.

2. Extended-coverage sprinklers.
3. Quick-response sprinklers.
4. Sidewall sprinklers.
5. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers. Escutcheons listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

1. Ceiling Mounting: Chrome-plated steel, 2 piece, with 3/4-inch vertical adjustment.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Sprinkler guards listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.13 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:

1. Elkhart Brass Mfg. Co., Inc.
2. Potter-Roemer; Fire-Protection Div.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

1. Type: Exposed, projecting, with two inlets and round escutcheon plate.
2. Type: Flush, with two inlets and square or rectangular escutcheon plate.
3. Finish: Polished brass.

2.14 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.

1. Manufacturers:
   a. AFAC Inc.
   b. Firematic Sprinkler Devices, Inc.
   c. Globe Fire Sprinkler Corporation.
   d. Reliable Automatic Sprinkler Co., Inc.
   e. Tyco Fire Protection Products by Johnson Controls Company.
   f. Viking Corp.

C. Electrically Operated Alarm: UL 464, with 6-inch- minimum-diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.

1. Manufacturers:

a. Potter Electric Signal Company.

b. System Sensor.

D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:

a. Potter Electric Signal Company.

b. System Sensor.

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:

a. Potter Electric Signal Company.

b. System Sensor.

F. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Manufacturers:

a. Potter Electric Signal Company.

b. System Sensor.

2.15 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge.

2. Ashcroft Inc.

3. Marsh Bellofram.

4. Viking Corp.

5. Weiss Instruments, Inc.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

2. Air System Piping: Include caption "AIR" or "AIR/WATER" on dial face.

PART 3 EXECUTION

3.01 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.02 **EARTHWORK**

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.03 **EXAMINATION**

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.04 **PIPING APPLICATIONS, GENERAL**

A. Flanges, flanged fittings, unions, nipples, grooved-joint couplings, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

B. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints; or grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

C. Underground Service-Entrance Piping: Ductile-iron, push-on or mechanical-joint pipe and fittings and restrained joints.

3.05 **SPRINKLER RISER AND STANDPIPE SYSTEM PIPING APPLICATIONS**

A. Sprinkler Risers and Standpipes: Use the following:

Pipe Type	4” & Smaller	5” & 6”	8” - 12”
Standard weight steel, threaded fittings	YES	YES	NO
Standard weight steel, grooved fittings	YES	YES	YES
Standard weight steel, welded fittings	YES	YES	YES
Galv. standard weight steel, threaded fittings	YES	YES	NO
Galv. standard weight steel, grooved fittings	YES	YES	YES
Type K copper, grooved fittings	NO	NO	NO
Type L copper, grooved fittings	NO	NO	NO
Type K copper, brazed fittings	NO	NO	NO
Type L copper, brazed fittings	NO	NO	NO

3.06 **SPRINKLER SYSTEM PIPING APPLICATIONS**

A. Wet-Pipe Sprinklers: Use the following:

Pipe Type	1 ½" & Smaller	2"	2 ½" – 3 ½"	4"	5" – 6"
Standard weight steel, threaded fittings	YES	YES	YES	YES	NO
Standard weight steel, grooved fittings	NO	NO	YES	YES	YES
Standard weight steel, welded fittings	NO	YES	YES	YES	YES
Galv. standard weight steel, threaded fittings	YES	YES	YES	YES	YES
Galv. standard weight steel, grooved fittings	NO	NO	YES	YES	YES
Schedule 10 steel, welded fittings	NO	YES	YES	YES	YES
Schedule 10 steel, grooved fittings	NO	NO	YES	YES	YES
Type K copper, brazed fittings	NO	NO	NO	NO	NO
Type L copper, brazed fittings	NO	NO	NO	NO	NO
Type K copper, brazed fittings	NO	NO	NO	NO	NO
Type L copper, grooved fittings	NO	NO	NO	NO	NO
CPVC pipe, solvent cement fittings	YES	YES	YES	NO	NO

3.07 **VALVE APPLICATIONS**

A. The following requirements apply:

1. Listed Fire-Protection Valves: UL listed or FMG approved for applications where required by NFPA 13.
    a. Shutoff Duty: Use ball, butterfly, or gate valves.
2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.
    a. Shutoff Duty: Use ball, butterfly, or gate valves.
    b. Throttling Duty: Use ball or globe valves.

3.08 **JOINT CONSTRUCTION**

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

C. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

D. Use of saddle style tees is not acceptable.

E. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. All grooved couplings, fittings, gaskets, valves, and specialties shall be the product of a single manufacturer.

2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

3. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.

F. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Refer to Division 20 Section “Basic Mechanical Materials and Methods” for additional requirements.

3.09 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 33 Section "Water Distribution" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Refer to Division 33 Section "Water Distribution" for backflow preventers.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.10 WATER-SUPPLY CONNECTION

A. Connect fire-suppression piping to building's interior water distribution piping.

B. Install shutoff valve, backflow prevention device, pressure gage, drain, and other accessories indicated at connection to water distribution piping.

3.11 PIPING INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints.

C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

E. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install drain valves on standpipes.

J. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

K. Install alarm devices in piping systems.

L. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install standpipe system piping according to NFPA 14.
2. Install sprinkler system piping according to NFPA 13, except use of “C” clamps, or beam clamps of “C” pattern, or any modification thereof, is prohibited for supporting pipes larger than NPS 2-1/2.
3. Refer to Division 20 Section “Hangers and Supports” for additional requirements.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

N. Fill wet-pipe sprinkler system piping with water.

3.12 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

D. Specialty Valves:

1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.13 SPRINKLER APPLICATIONS

A. Use the following sprinkler types:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Sidewall, dry sprinklers.
5. Sprinkler Finishes:
    a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes; white polyester finish in natatoriums.
    b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
6. Sprinkler Guards: For exposed sprinkler heads subject to damage.

3.14 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

C. Install sprinklers into flexible sprinkler drop fittings and install into bracket on ceiling grid. Install according to manufacturer’s instructions and NFPA, State, and local guidelines. Ceiling grid must meet requirements of ASTM C 635 and C 636, coordinate with ceiling installer.

3.15 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall.

B. Install freestanding-type, fire department connections in level surface.

1. Install protective pipe bollards on two sides of each fire department connection. Refer to Division 05 Section "Metal Fabrications" for pipe bollards.

C. Install ball drip valve at each check valve for fire department connection.

3.16 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

C. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

D. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

E. Connect compressed-air supply to dry-pipe sprinkler piping.

F. Electrical Connections: Power wiring and fire alarm wiring are specified in Division 26.

G. Connect alarm devices to fire alarm.

H. Ground equipment according to Division 26 Section "Grounding and Bonding."

I. Connect wiring according to Division 26 Section "Conductors and Cables."

J. 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.

3.17 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 20 Section "Mechanical Identification."

3.18 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

4. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.

5. Verify that equipment hose threads are same as local fire department equipment.

6. Test each backflow prevention device according to authorities having jurisdiction and the device's reference standard.

B. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

C. Verify that specified tests of piping are complete.

D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

F. Verify that potable-water supplies have correct types of backflow preventers.

G. Energize circuits to electrical equipment and devices.

H. Coordinate with fire alarm tests. Operate as required.

I. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.19 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

3.20 DEMONSTRATION

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

END OF SECTION

SECTION 22 0523 - GENERAL DUTY VALVES FOR PLUMBING

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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 include the following:

1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
2. Division 20 Section "Mechanical Identification" for valve tags and charts.
3. Division 22 Piping Sections for specialty valves applicable to those Sections only.
4. Division 23 Section “General-Duty Valves for HVAC” for HVAC valves.
5. Division 23 Section "Temperature Controls" for control valves and actuators.

1.02 SUMMARY

A. This Section includes valves for general plumbing applications. Refer to piping Sections for specialty valve applications.

1.03 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. NRS: Nonrising stem.
5. OS&Y: Outside screw and yoke.

6. PTFE: Polytetrafluoroethylene plastic.
7. RPTFE: Reinforced polytetrafluoroethylene plastic.
8. SWP: Steam working pressure.
9. TFE: Tetrafluoroethylene plastic.
10. WOG: Water, oil, and gas.

1.04 **SUBMITTALS**

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1. Certification that products for use in potable water systems comply with NSF 61 and NSF 372.

1.05 **QUALITY ASSURANCE**

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.06 **DELIVERY, STORAGE, AND HANDLING**

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 **VALVES, GENERAL**

A. Isolation valves are scheduled on the Drawings. For other general plumbing valve applications, use the following:

1. Throttling Service: Angle, ball, butterfly, or globe valves.
2. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

D. For valves not indicated in the Application Schedules, select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Systems: Valve ends may be grooved.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted unless otherwise noted.

F. Wetted surfaces of valves contacted by consumable water shall contain not more than 0.25 percent weighted average lead content.

1. Exceptions:
    a. Valves in pumped sanitary systems.
    b. Valves in pumped storm systems.
    c. Drain valves.
    d. Valves in general air or vacuum systems.
    e. Valves in irrigation systems.
    f. Valves in non-potable water systems.
    g. Valves in other plumbing systems not intended for human consumption.

G. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

H. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
3. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller.

I. Extended Valve Stems: On insulated valves.

J. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

K. Valve Grooved Ends: AWWA C606.

L. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.

M. Threaded: With threads according to ASME B1.20.1.

N. Valve Bypass and Drain Connections: MSS SP-45.

2.02 **BRONZE BALL VALVES**

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.

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

a. Apollo Valves; by Conbraco Industries, Inc.; Series 70LF-140/240.

b. Hammond Valve.

c. Kitz Corporation; Kitz Valves.

d. Milwaukee Valve Company; Model UPBA100S/150S.

e. NIBCO INC.; Models S-580-70-66-LF/T-580-70-66-LF.

f. Watts Water Technologies, Inc.

C. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.

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

a. Apollo Valves; by Conbraco Industries, Inc.; Series 77CLF-A Series.

b. Hammond Valve.

c. Kitz Corporation; Kitz Valves.

d. Milwaukee Valve Company; UPBA400S/450S.

e. NIBCO INC.; Models S-585-70-66-LF/T-585-70-66-LF.

f. Watts Water Technologies, Inc.; Series LFB6080G2/LFB6081G2.

2.03 **GENERAL SERVICE BUTTERFLY VALVES**

A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.

2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

B. Lug-Style (Single-Flange) Size NPS 2-1/2 through NPS 12, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body,

Type 416 stainless-steel stem, copper bushing, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Apollo Valves; by Conbraco Industries, Inc.; Series 143 and Series LD145.
    b. Bray International, Inc.
    c. DeZurik.
    d. Emerson Automation Solutions; Keystone.
    e. Forum Energy Technologies; ABZ Valve.
    f. Hammond Valve.
    g. Milwaukee Valve Company.
    h. NIBCO INC.; LD-2000-3/5.
    i. Tyco Flow Control; Grinnell Flow Control.
    j. Watts Water Technologies.

C. Grooved-End Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron body with grooved or shouldered ends and polyamide coating inside and outside; Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Anvil International, Inc.
    b. NIBCO INC.; Model GD-4765-3/5.
    c. Victaulic Co. of America.

2.04 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 125, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Apollo Valves; by Conbraco Industries, Inc.; Model 162T-LF and 163T-LF (61YLF Series).
    b. Milwaukee Valve Company; Model UP509/UP1509.
    c. NIBCO INC.; Models S-413-B-LF or T-413-B-LF.
    d. Watts Water Technologies; LFCVY/LFCVYS.

2.05 LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic TFE Disc:

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

a. Apollo Valves; by Conbraco Industries, Inc.; Model CBV-LF (61LF Series).

b. Hammond Valve; UP943 and UP947.

c. Milwaukee Valve Company; UP548T and UP1548T.

d. NIBCO INC.; Model S-480-Y-LF and T-480-Y-LF.

e. Watts Water Technologies; LF600.

2. Description:

a. Standard: MSS SP-80, Type 2.

b. CWP Rating: 250 psig.

c. Body Design: Vertical flow.

d. Body Material: Lead free brass or bronze.

e. Ends: Threaded or Solder.

f. Disc: PTFE, or TFE.

2.06 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.

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

a. NIBCO INC.; Model W-910-B-LF.

b. Mueller Steam Specialty.

c. Milwaukee Valve Company.

d. Hammond Valve.

C. Class 250, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 400 psig CWP rating.

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

a. NIBCO INC.; Model W-960-B-LF.

b. Mueller Steam Specialty.

c. Milwaukee Valve Company.

d. Hammond Valve.

D. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.

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

a. NIBCO INC.; Model F-910-B-LF.

b. Mueller Steam Specialty.

c. Milwaukee Valve Company.

d. Hammond Valve.

E. Class 250, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 400 psig CWP rating.

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

a. NIBCO INC.; Model F-960-B-LF.

b. Mueller Steam Specialty.

c. Milwaukee Valve Company.

d. Hammond Valve.

2.07 BRONZE GLOBE VALVES

A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.

B. Class 125, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, Provide products by one of the following:

a. Apollo Valves; by Conbraco Industries, Inc.; Model 121T-LF.

b. Hammond Valve; UP418 and UP440.

c. Milwaukee Valve Company; Model UP502 and UP1502.

d. Watts Water Technologies, Inc.; LFGLV.

2.08 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Bronze ball valve as specified in this Section. Lead free construction is not required.

2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.09 SOURCE QUALITY CONTROL

A. Identification: Factory label or color coding to identify lead free valves.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.02 **VALVE INSTALLATION**

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Lift Check Valves: With stem upright and plumb.

3.03 **JOINT CONSTRUCTION**

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.04 **ADJUSTING**

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

SECTION 22 1116 - DOMESTIC WATER PIPING

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods” for materials and methods common to mechanical piping systems.
3. Division 20 Section “Hangers and Supports.”
4. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
5. Division 22 Section “Plumbing Valves” for general duty plumbing valves.
6. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.02 SUMMARY

A. This Section includes domestic water piping inside the building.

B. Water meters will be furnished by utility company for installation by Contractor.

1.03 DEFINITIONS

A. PEX: Crosslinked polyethylene plastic.

1.04 **PERFORMANCE REQUIREMENTS**

A. Where not indicated on the Drawings, provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1. Exception: PEX plastic piping insert fittings specified are limited to 100 psig.

1.05 **SYSTEMS DESCRIPTION**

A. Potable and non-potable domestic water piping system materials are scheduled on the Drawing.

B. Under-Building-Slab, Water-Service Piping on Service Side of Water Meter: Refer to Division 22 Section “Facility Water Distribution.”

C. Refer to Application Schedules on the Drawings for valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.

2. Drain Duty: Hose-end drain valves.

3. Isolation Valves at Domestic Water Meters: Gate Valves, NPS 2 and Smaller: Class 150, bronze.

4. Isolation Valves at Domestic Water Meters: Gate Valves, NPS 2-1/2 and Larger: Class 125, OS&Y, bronze-mounted cast iron.

D. Transition and special fittings with pressure ratings at least equal to piping rating may be used unless otherwise indicated.

1.06 **SUBMITTALS**

A. Product Data: For pipe, tube, fittings, and couplings.

B. Water Samples: Specified in Part 3 "Cleaning" Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Fire-suppression-water piping.

2. Domestic water piping.

3. Compressed air piping.

4. HVAC hydronic piping.

D. Field quality-control test reports.

1.07 **QUALITY ASSURANCE**

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

E. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

1.08 **COORDINATION**

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **PIPING MATERIALS**

A. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.03 **COPPER TUBE AND FITTINGS**

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.

3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.

3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

C. Grooved-Joint Systems:

1. Manufacturers:

a. Anvil International, Inc.; Gruvlok Manufacturing; Advanced Copper Method.

b. Victaulic Company; Style 606 and Style 607.

2. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

3. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

D. Copper or Bronze Pressure-Seal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Viega North America; ProPress System.

b. NIBCO Inc.; Press System.

c. Mueller Industries, Inc.; Streamline PRS.

d. Elkhart Products Corporation; an Aalberts Industries Company; Xpress.

e. Apollo Valves; by Conbraco Industries; ApolloXpress.

2. Housing: Copper.

3. O-Rings and Pipe Stops: EPDM.

4. Tools: Manufacturer's special tools.

5. Maximum 200-psig working-pressure rating at 250 deg F.

E. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube. Mechanically formed tee fittings may be used up to half size of main.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. T-DRILL Industries Inc.

2.04 **VALVES**

A. General-duty plumbing valves; and drain valves are specified in Division 22 Section "Plumbing Valves."

B. Balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."

PART 3 EXECUTION

3.01 **EXCAVATION**

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earthwork."

3.02 **PIPING SYSTEM INSTALLATION**

A. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Install under-building-slab copper tubing according to Copper Development Association’s "Copper Tube Handbook." Joints under slab are not allowed. Install PVC sleeve where piping penetrates slab.

C. Install sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."

D. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 20 Section "Basic Mechanical Materials and Methods."

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 20 Section "Meters and Gages," and strainers are specified in Division 22 Section "Domestic Water Piping Specialties."

F. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops.

G. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves at low points in water mains, risers, and branches.

2. Install stop-and-waste drain valves where indicated.

H. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."

I. Install domestic water piping level without pitch and plumb.

3.03 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. PEX Piping Joints: Join according to ASTM F 1807.

3.04 WATER METER INSTALLATION

A. Rough-in domestic water piping for water meter installation and install water meters according to utility company's requirements.

B. Water meters will be furnished by utility company.

3.05 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Division 20 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.

2. Individual, Straight, Horizontal Piping Runs: According to the following:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.

c. Longer than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.

2. NPS 1-1/2: 108 inches with 3/8-inch rod.

3. NPS 2: 10 feet with 3/8-inch rod.

4. NPS 2-1/2: 11 feet with 1/2-inch rod.

5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.

6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

F. Install supports for vertical steel piping every 15 feet.

G. Install hangers for drawn-temper copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60-inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Soft copper tube: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.

J. Alternate support for copper tubing NPS 3/4 and smaller: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.

K. Install hangers for Schedule 10 stainless steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.
2. NPS 2-1/2: 84 inches with 1/2-inch rod.
3. NPS 3: 96 inches with 1/2-inch rod.
4. NPS 4: 10 feet with 5/8-inch rod.
5. NPS 6: 11 feet with 3/4-inch rod.
6. NPS 8: 12 feet with 7/8-inch rod.
7. NPS 10 to NPS 12: 14 feet with 7/8-inch rod.

L. Install supports for vertical Schedule 10 stainless steel piping every 15 feet.

M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic water piping to distribution side of water meter with shutoff valve.

C. Install piping adjacent to equipment and machines to allow service and maintenance.

D. Connect domestic water piping to the following:

1. Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."

4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.07 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 150 psig. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.08 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.09 CLEANING AND DISINFECTION

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:
        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION

SECTION 22 1119 - DOMESTIC WATER PIPING SPECIALTIES

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
4. Division 22 Section "Domestic Water Piping" for water meters.
5. Division 22 Section "Medical Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
6. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
7. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.03 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Flow Reports and Settings: For calibrated balancing valves.

E. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.04 **QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

C. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

3. Comply with NSF 372, “Drinking Water System Components – Lead Content” for components with wetted surfaces in contact with potable water.

PART 2 PRODUCTS

2.01 **VACUUM BREAKERS**

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

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

a. Apollo Valves; Conbraco Industries, Inc.

b. FEBCO; a Division of Watts Water Technologies, Inc.

c. Watts Water Technologies, Inc.; Watts Regulator Co.

d. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1001.

3. Size: NPS 1/4 to NPS 3, as required to match connected piping.

4. Body: Bronze.

5. Inlet and Outlet Connections: Threaded.

6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

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

a. Apollo Valves; Conbraco Industries, Inc.

b. MIFAB, Inc.

c. Watts Water Technologies, Inc.; Watts Regulator Co.

d. Woodford Manufacturing Company.

2. Standard: ASSE 1011.
3. Body: Bronze or brass, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. FEBCO; a Division of Watts Water Technologies, Inc.
   c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
   d. Watts Water Technologies, Inc.; Watts Regulator Co.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Size and Capacity: As indicated on the drawings.
6. Accessories:
   a. Valves: Ball type, on inlet and outlet.

2.02 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. FEBCO; a Division of Watts Water Technologies, Inc.
   c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
   d. Watts Water Technologies, Inc.; Watts Regulator Co.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Size and Capacities: As scheduled on the drawings.
6. Body: Bronze for NPS 2 and smaller; cast-iron or ductile-iron, with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:

a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

c. Y-Pattern strainer and soft-seated check valve.

2.03 **BALANCING VALVES**

A. Calibrated Balancing Valves NPS 1/2:

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

a. Armstrong International, Inc.

b. Armstrong Pumps, Inc.

c. Apollo Valves; by Conbraco Industries, Inc.

d. Bell & Gossett; Xylem Inc.

e. Flo Fab Inc.

f. Flow Design Inc.

g. Griswold Controls.

h. NIBCO INC.

i. IMI Indoor Climate; Tour & Andersson.

j. Taco, Inc.

k. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.

3. Body: Dezincification resistant brass, or bronze.

4. Minimum Flow Rate: 0.3 gpm.

5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Calibrated Balancing Valves NPS 3/4 to NPS 2:

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

a. Armstrong International, Inc.

b. Armstrong Pumps, Inc.

c. Apollo Valves; by Conbraco Industries, Inc.

d. Bell & Gossett; Xylem Inc.

e. Flo Fab Inc.

f. Flow Design Inc.

g. Griswold Controls.

h. NIBCO INC.

i. IMI Indoor Climate; Tour & Andersson.

j. Taco, Inc.

k. Watts Water Technologies, Inc.; Watts Regulator Co.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Dezincification resistant brass, or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Calibrated Balancing Valves NPS 2-1/2 to NPS 4:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Bell & Gossett; Xylem Inc.
   c. Flo Fab Inc.
   d. Flow Design Inc.
   e. Griswold Controls.
   f. NIBCO INC.
   g. IMI Indoor Climate; Tour & Andersson.
   h. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.04 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Controls; Morris Group International; ST70.
   b. Apollo Valves; Conbraco Industries, Inc.; Model MVD (34D Series).
   c. Bradley Corporation.
   d. Lawler Manufacturing Company, Inc.
   e. Leonard Valve Company; Series 170-LF and 270-LF.
   f. Watts Water Technologies, Inc.; Powers Division; Hydroguard Series LFe480, LFG480, and LFLM495.
   g. Watts Water Technologies, Inc.; Watts Regulator Co.
   h. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: 1/2-inch union or 3/8-inch compression; with integral check valves.

7. Accessories: Adjustable temperature-control knob.
8. Outlet Temperature Range: Adjustable from 85 deg F to 120 deg F. Set at 105 deg F.
9. Minimum Flow Rate: 0.5 gpm.
10. Valve Finish: Rough bronze.

2.05 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. Keckley.
   c. Metraflex.
   d. Mueller Steam Specialty.
   e. NIBCO, Inc.
   f. Spence.
   g. SSI Equipment, Inc.
   h. Watts Water Technologies, Inc.
   i. Yarway.
2. CWP: 200 psig minimum, unless otherwise indicated.
3. SWP: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
5. End Connections: Threaded or soldered for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Screen: Stainless steel with round perforations, unless otherwise indicated.
7. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.033 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
   c. Strainers NPS 5 and Larger: 0.045 inch.
8. Drain: Pipe plug.

2.06 OUTLET BOXES

A. Water Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Engineering Company.
   b. LSP Products Group, Inc.
   c. Oatey SCS.
2. Mounting: Recessed.

3. Material and Finish: Enameled- or epoxy-painted-steel or Stainless-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.07 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.08 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (Copper Tube Type):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. MIFAB, Inc.
    b. PPP Inc.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

B. Water Hammer Arresters (Metal Bellows Type):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AMTROL, Inc.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products Inc.
    g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Precharged stainless steel bellows.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.09 **AIR VENTS**

A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:
1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

PART 3 EXECUTION

3.01 **INSTALLATION**

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe

diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

3. Do not install bypass piping around backflow preventers.

4. Install strainer and soft-seated check valve upstream of backflow preventer. Exception: Fire protection backflow preventers.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated water mixing valves with strainers, and check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.

2. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of pump.

F. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

G. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install shutoff valve on outlet if specified.

2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

H. Install water hammer arresters in water piping according to PDI-WH 201.

I. Install air vents at high points of water piping.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.03 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.

2. Intermediate atmospheric-vent backflow preventers.

3. Reduced-pressure-principle backflow preventers.

4. Dual-check-valve backflow preventers.

5. Calibrated balancing valves.

6. Primary, thermostatic, water mixing valves.

7. Outlet boxes.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 20 Section "Mechanical Identification."

3.04 **FIELD QUALITY CONTROL**

A. Perform the following tests and prepare test reports:

1. Test each backflow prevention device according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.05 **ADJUSTING**

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves as follows:

1. Set calibrated balancing valves at calculated presettings.

2. Measure flow each station and adjust where necessary.

3. Record settings and mark balancing devices.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

SECTION 22 1123 - DOMESTIC WATER CIRCULATION PUMPS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section "Packaged Booster Pumps" for booster systems.
4. Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

1.02 SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

1.03 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

E. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.04 **DELIVERY, STORAGE, AND HANDLING**

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.05 **COORDINATION**

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS (SMALL)**

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Bell & Gossett; Xylem Inc.; Series PL.
3. Grundfos Pumps Corp.
4. Taco, Inc.; Series 1400.

B. Description: Factory-assembled and –tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.

1. Pump Construction: All bronze.
   a. Casing: Radially split, bronze, with threaded companion-flange connections.
   b. Impeller: Glass-reinforced corrosion-resistant material; keyed to shaft.
   c. Shaft: High-strength alloy steel.
   d. Seal: Mechanical, carbon/silicon carbide seal.
   e. Bearings: Permanently oil-lubricated type.
2. Motor-Single speed, with oil-lubricated bearings, unless otherwise indicated; and directly mounted to pump casing. Comply with requirements in Division 20 Section “Motors.”

C. Capacities and Characteristics: Refer to Schedule on Drawings.

2.03 **CONTROLS**

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Manufacturers:

a. Honeywell International, Inc.; Aquastat.

b. Johnson Controls, Inc.

c. Schneider Electric USA, Inc.

d. Siemens Industry, Inc.; Building Technologies Division.

e. White-Rodgers Div.; Emerson Electric Co.

2. Type: Strap-on sensor, with suitable removable spring clip attaching thermostat to hot-water circulation piping.

3. Range: 65 to 200 deg F.

4. Operation of Pump: On or off.

5. Transformer: Provide if required.

6. Power Requirement: 24 V, ac or 120 V, ac.

7. Settings: Start pump at 110 deg F and stop pump at 120 deg F.

2.04 **FLEXIBLE CONNECTORS**

A. Refer to Division 20 Section “Pipe Flexible Connectors, Expansion Fittings and Loops.”

2.05 **BUILDING-AUTOMATION-SYSTEM INTERFACE**

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.

2. Alarm status.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.02 **PUMP INSTALLATION**

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping. Do not use pump motors as a support point.

D. Install centrifugal pumps with motor and pump shafts horizontal.

E. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 20 Section "Mechanical Vibration Controls." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 20 Section "Hangers and Supports."

F. Install vertical in-line pumps on concrete bases. Install pumps with motor and pump shafts vertical.

3.03 CONTROL INSTALLATION

A. Install thermostats in hot-water return piping.

B. Install timers where indicated on Drawings.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

   a. Separately coupled, in-line centrifugal pumps.

   b. Separately coupled, horizontally mounted, in-line centrifugal pumps.

   c. Close-coupled, horizontally mounted, in-line centrifugal pumps.

   d. Close-coupled, vertically mounted, in-line centrifugal pumps.

2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 20 Section "Valves" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.

3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 20 Section "Meters and Gages" for pressure gages and gage connectors.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. Connect thermostats to pumps that they control.

G. Interlock pump with water heater burner and time delay relay.

3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Set thermostats for automatic starting and stopping operation of pumps.

5. Perform the following startup checks for each pump before starting:

   a. Verify bearing lubrication.

   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.06 **DEMONSTRATION**

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

END OF SECTION

SECTION 22 1124 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section "Domestic Water Pumps" for domestic water circulation pumps.

1.02 SUMMARY

A. This Section includes variable-speed, duplex, packaged booster pumps for domestic water systems.

1.03 DEFINITIONS

A. EEPROM: Electrically erasable programmable read-only memory.

B. PID: Proportional plus integral plus derivative.

1.04 SUBMITTALS

A. Product Data: For each packaged booster pump specified include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: For packaged booster pumps and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
3. Wiring Diagrams: Detail power, signal, and control wiring.

C. Operation and Maintenance Data: For each packaged booster pump to include in operation and maintenance manuals.

1.05 **QUALITY ASSURANCE**

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged booster pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

E. ASME Compliance: Comply with ASME B31.9 for piping.

F. Packaged booster pumps shall be listed and labeled as pumping systems by testing agency acceptable to authorities having jurisdiction.

1.06 **DELIVERY, STORAGE, AND HANDLING**

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.07 **COORDINATION**

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **VARIABLE-SPEED, MULTIPLEX BOOSTER PUMPS**

A. Description: Factory-assembled and -tested, packaged booster pump with multiple pumps, piping, valves, sensors, variable frequency drive, and controls on skids or base.

B. System Working-Pressure Rating: 150 psig minimum.

C. Pump Arrangement: Duplex, with two equal-size pumps sized as scheduled on the Drawings.

D. Pumps: Overhung impeller assembly, separately coupled, vertically mounted, multistage, in-line, centrifugal. Comply with UL 778 and HI 1.1-1.2 and HI 1.3.

1. Manufacturers:

a. Armstrong Pumps, Inc.

b. Aurora Pump; Pentair Pump Group (The).

c. Bell & Gossett; Xylem Inc.

d. Canariis Corporation.

e. Metropolitan Industries, Inc.

f. Peerless Pump Company.

g. QuantumFlo, Inc.

h. SynchroFlo, Inc.

2. Each Pump:

a. Construction: Stainless-steel fitted.

1) Casing: Cast-iron base and head sections.

2) Impellers, Diffusers, and Discharge Sleeve: Stainless steel.

3) Shaft: Stainless steel.

4) Seal: Mechanical.

b. Coupling: Rigid type.

E. Motors: Select motor that will not overload through full range of pump performance curve. Comply with Division 20 Section "Motors."

F. Relief Valves: Adjustable, pressure relief type on pump discharge.

G. Piping: ASME B31.9 for piping materials and installation.

1. NPS 4 and Smaller: ASTM B 88, Type L, drawn copper water tube; with copper solder-joint pressure fittings, and brazed joints or ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded, cast-iron fittings and threaded joints.

2. NPS 5 and Larger: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded, cast-iron fittings and threaded joints.

3. Header End Connections:

a. NPS 2 and Smaller: Threaded.

b. NPS 2-1/2 and Larger: Flanged.

4. Piping Option: Piping, including valves and other components, may have grooved ends for grooved joints.

H. Valves: Include shutoff valve at each pump suction, and shutoff valve and check valve at each pump discharge.

1. Shutoff Valves, NPS 2 and Smaller: MSS SP-80, Class 125, bronze rising-stem gate valve or MSS SP-110, 600-psig minimum CWP, bronze ball valve with ends matching piping.

2. Shutoff Valves, NPS 2-1/2 and Larger: MSS SP-70, Class 125, bronze-trim, OS&Y, cast-iron gate valve with flanged ends or MSS SP-67, Type I for tight shutoff, 175-psig CWP, single-flanged, cast-iron butterfly valve.

3. Check Valves, NPS 2 and Smaller: Spring- or lever-loaded, MSS SP-80, Class 125, bronze, swing check valve.

4. Check Valves, NPS 2-1/2 and Larger: Spring- or lever-loaded, MSS SP-71, Class 125, bronze-trim, cast-iron, swing check valve.

I. Sensors: Pressure and flow switches.

J. Dielectric Fittings: With insulating material isolating joined dissimilar metals to prevent galvanic action and to stop corrosion.

1. NPS 2 and Smaller: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

2. NPS 2-1/2 and Larger: Factory-fabricated, companion-flange assembly; for 150- or 300-psig minimum working pressure as required to suit system pressures.

K. Variable Frequency Drives:

1. Provide and mount on the system skid variable frequency drives suitable for variable torque applications using any standard NEMA Design B squirrel cage induction motor.

2. Variable frequency drives: Sized for maximum possible amp draw throughout the programmed sequence of pump operation.

3. Refer to Division 20 Section ‘Variable Frequency Controllers” for additional requirements.

L. Control Panel: Factory installed and connected as an integral part of unit complying with NEMA ICS 2 and UL 508; automatic for multiple-pump, variable-speed operation, with load control and protection functions.

1. Field Power Interface: NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000 A.

2. Enclosures: NEMA 250, Type 2.

3. Logic Section:

a. Provide, mount and wire on the skid a programmable logic controller to interface the signal from the pressure sensor to the VFC’s and provide a stabilized response to speed up or slow down pump(s) or add the lag pump(s) to meet system requirements.

b. Controller shall provide setpoint adjustment, timer adjustment, PID functions and both system and controller self diagnostics via touch screen display.

c. User interface setpoints accessible via password protected display screen.

d. Normal system operation tuned to eliminate hunting.

e. Controller shall have one RS 485 communication port, real time calendar/clock and EEPROM memory transfer cartridge.

4. Power Section:

a. UL listed enclosed industrial control panel, factory mounted and wired on the steel skid.

b. Panel shall be furnished with individual pump disconnects with lockout handles and having SCCR to match main disconnecting means, pump run lights, H-O-A selector switches and 115 volt fused control transformer.

5. Instrumentation: Unit suction and discharge pressure gages.

6. Alarm Signal Device: Sounds alarm when backup pumps are operating.

7. High-suction pressure cutout.

8. High-discharge pressure cutout.

9. Remote signal contacts.

M. Sequence of Operation:

1. Lead pump shall run only as necessary to maintain system pressure and will be controlled automatically by means of a pressure sensor/transmitter and programmable logic controller (PLC) programmed to prevent short cycling.

2. If lead pump is unable to maintain system pressure, lag pump(s) will be called on after a time delay and will operate in parallel with the lead pump in accordance with the PLC program.

3. When one pump can handle the system demand the controls will shut down the lag pump (s).

4. When a low or no flow condition is reached, the controls will accelerate the lead pump to charge the system and hydro-pneumatic tank then shut the lead pump down and alternate.

N. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and pump nozzles.

2.03 HYDROPNEUMATIC TANKS

A. Description: Steel, pressure-rated tank, ASME-code constructed with welded joints and factory-installed, butyl-rubber bladder. Include air pre-charge to minimum system-operating pressure at tank.

1. Manufacturers:

a. AMTROL Inc.

b. Armstrong Pumps, Inc.

c. Bell & Gossett; Xylem Inc.

d. Taco, Inc.

e. Wessels Co.

2. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics: Refer to Schedule on Drawings.

2.04 **BUILDING-AUTOMATION-SYSTEM INTERFACE**

A. Provide building-automation-system communication via 4 to 20mA analog signal and digital outputs. Serial communication utilizing BACnet MSTP protocol.

B. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.

2. Alarm status.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine roughing-in for packaged booster pumps to verify actual locations of connections before booster pump installation.

3.02 **CONCRETE BASES**

A. Install concrete bases of dimensions indicated for packaged booster pumps. Refer to Division 20 Section "Basic Mechanical Materials and Methods."

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.03 **BOOSTER PUMP INSTALLATION**

A. Install packaged booster pumps level on concrete bases with access for periodic maintenance including removal of pumps, motors, impellers, couplings, and accessories.

1. Do not dismantle packaged booster pumps or remove individual components.

B. Vibration Isolation: Install on spring isolators with minimum as specified in Division 20 Section "Mechanical Vibration Controls."

C. Support connected domestic water piping so weight of piping is not supported by packaged booster pumps.

3.04 **CONNECTIONS**

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect domestic water piping to packaged booster pumps. Install suction and discharge pipe equal to or greater than size of unit suction and discharge piping.

1. Install flexible connectors on piping connections to unit suction and discharge piping. Install flexible connectors same size as piping.

2. Install shutoff valves on piping connections to each booster pump suction and discharge piping. Install ball, butterfly, or gate valves same size as suction and discharge piping. General-duty valves are specified in Division 20 Section "Valves."

3. Install union or flanged connections on pump suction and discharge piping at connection to domestic water piping.

4. Install piping adjacent to packaged booster pumps to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform the following startup service:

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers if any.
4. Verify that pump controls are correct for required application.

B. Perform the following startup checks for each pump of packaged booster pump unit before starting:

1. Verify bearing lubrication.
2. Prime pumps by opening suction valves and closing discharge valves, and prepare pumps for operation.
3. Start motors.
4. Open discharge valves slowly.
5. Adjust settings.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting packaged booster pumps to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.06 LABELING AND IDENTIFICATION

A. Install identifying equipment markers and equipment signs on booster pumps. Labeling and identification materials are specified in Division 20 Section "Mechanical Identification."

3.07 DEMONSTRATION

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

END OF SECTION

SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

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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 include the following:

1. Division 20 Section “Mechanical General Requirements”.
2. Division 20 Section “Basic Mechanical Materials and Methods”.
3. Division 22 Section “Drainage Piping Specialties”.

1.02 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. LLDPE: Linear, low-density polyethylene plastic.

C. NBR: Acrylonitrile-butadiene rubber.

D. PE: Polyethylene plastic.

E. PVC: Polyvinyl chloride plastic.

F. TPE: Thermoplastic elastomer.

1.03 SYSTEMS DESCRIPTIONS

A. Sanitary waste and vent piping system materials are scheduled on the Drawing.

1.04 **SUBMITTALS**

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.05 **QUALITY ASSURANCE**

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).

C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

1.06 **PROJECT CONDITIONS**

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **HUBLESS CAST-IRON SOIL PIPE AND FITTINGS**

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers:

a. ANACO-Husky.

b. Ferguson Enterprises, Inc.; ProFlo (Private labeled Ideal Clamp Products, Inc.).

c. Ideal Clamp Products, Inc.; a Tomkins Company.

d. Mission Rubber Company; a division of MCP Industries, Inc.

e. Tyler Pipe.

2. Standards: CISPI 310.

3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.03 **COPPER TUBE AND FITTINGS**

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.04 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: Schedule 40, ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.05 SPECIALTY PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Dallas Specialty & Mfg. Co.

b. Fernco, Inc.

c. Logan Clay Products Company (The).

d. Mission Rubber Co.

e. NDS, Inc.

2. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.

b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Mission Rubber Co.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. ANACO.

D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

a. SIGMA Corp.

PART 3 EXECUTION

3.01 EXCAVATION

A. Comply with requirements in Division 31 Section “Earth Moving” for excavating, trenching, and backfilling.

3.02 PIPING SYSTEM INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

E. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.03 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.

2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.05 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 20 Section "Valves."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.06 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.08 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section "Mechanical Identification."

3.09 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.10 **CLEANING**

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 1319 - DRAINAGE PIPING SPECIALTIES

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”

2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PUR: Polyurethane plastic.

H. PVC: Polyvinyl chloride plastic.

1.03 **SUBMITTALS**

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in operation and maintenance manuals.

1.04 **QUALITY ASSURANCE**

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

1.05 **COORDINATION**

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.01 **CAST-IRON CLEANOUTS**

A. Size: Cleanouts shall be same nominal size as the pipe they serve up to 4 inches. For pipes larger than 4 inches nominal size, minimum size of cleanout shall be 4 inches.

B. Exposed Cast-Iron Cleanouts:

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

a. Josam Company; Josam Div.; Series 58910.

b. MIFAB, Inc.; C1460.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; 4510 Series.

d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.

3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.

4. Closure: Countersunk or raised-head, brass or bronze plug with tapered threads.

C. Cast-Iron Floor Cleanouts (On-Grade Interior Floor Areas):

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.; C1220-R.

c. Sioux Chief Manufacturing Company, Inc.

d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4023S-F.

e. Tyler Pipe; Wade Div.

f. Watts Drainage Products Inc.

g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.

3. Type: Adjustable housing.

4. Body or Ferrule: Cast iron.

5. Clamping Device: Not required.

6. Outlet Connection: Spigot.

7. Closure: Brass, bronze, or plastic plug with tapered threads.

8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.

9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.

10. Frame and Cover Shape: Round.

11. Top Loading Classification: Medium Duty.

12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

D. Cast–Iron Floor Cleanouts (Not-On-Grade Interior Floor Areas):

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.; C-1100-C-R-34.

c. Sioux Chief Manufacturing Company, Inc.

d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4333C.

e. Tyler Pipe; Wade Div.

f. Watts Drainage Products Inc.

g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.

3. Type: Adjustable housing.

4. Body or Ferrule: Cast iron.

5. Clamping Device: Required.

6. Outlet Connection: Spigot.

7. Closure: Brass, bronze, or plastic plug with tapered threads.

8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.

9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

E. Cast-Iron Wall Cleanouts (Finished Wall Areas):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.; Model 58790-20.
   b. MIFAB, Inc.; C1460-RD.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded bronze or brass plug with tapered threads.
5. Wall Access: Round, deep, chrome-plated bronze flat, chrome-plated brass or stainless-steel cover plate with screw.

2.02 PLASTIC CLEANOUTS

A. Size: Cleanouts shall be same nominal size as the pipe they serve up to 4 inches. For pipes larger than 4 inches nominal size, minimum size of cleanout shall be 4 inches.

B. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. IPS Corporation.
   b. MIFAB, Inc.
   c. NDS Inc.
   d. Sioux Chief Manufacturing Company, Inc.
   e. Zurn Plumbing Products Group; Light Commercial Operation.
2. Body: PVC.
3. Closure Plug: PVC.
4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.03 BACKWATER VALVES

A. Horizontal, Plastic Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Canplas LLC.
    b. IPS Corporation.
    c. NDS Inc.
    d. Oatey.
    e. Plastic Oddities; a division of Diverse Corporate Technologies.
    f. Sioux Chief Manufacturing Company, Inc.; ProCheck.
    g. Zurn Plumbing Products Group; Light Commercial Operation.
2. Size: Same as connected piping.
3. Body: PVC.
4. Cover: Same material as body with threaded access to check valve.
5. Check Valve: Removable swing check.
6. End Connections: Socket type.
7. Deep-Bury Adapters: Same material as body, with solvent weld connections to extension.
8. Extension: NPS 6, Schedule 40 PVC extension to backwater valve cover at floor.

2.04 **FLOOR DRAINS**

A. Cast-Iron Floor Drains (Toilet Rooms, Kitchen and Janitor's Closet) FD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Sioux Chief Manufacturing Company, Inc.; Finish Line Adjustable Drainage System.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2005Y-A.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products Inc.
    g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Enamel.
9. Top or Strainer Material: Nickel bronze.
10. Top of Body and Strainer Finish: Nickel bronze.

11. Top Shape: Round, with vandal proof screws.
12. Dimensions of Top or Strainer: 7 inch diameter.
13. Top Loading Classification: Light Duty.
14. Funnel: Not required.
15. Inlet Fitting: Gray iron, with spigot outlet.

B. Cast-Iron Floor Drains (Mechanical Rooms and Electrical Rooms) FD-2:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2142Y.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.
    f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Enamel.
9. Sediment Bucket: 3-3/4 inches deep, slotted sediment bucket with lift bar.
10. Top or Strainer Material: Cast-iron.
11. Top Shape: Round.
12. Dimensions of Top or Strainer: 11-1/2 inch diameter tractor grate, 29 square inches of free area. Provide partial grate where required to accept equipment drains.
13. Top Loading Classification: Heavy Duty.
14. Funnel: Not required.
15. Outlet Fitting: Gray iron, with spigot outlet.

C. Cast-Iron Floor Sink Drains FS-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    d. Tyler Pipe; Wade Div.
    e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

g. Commercial Enameling Co.

h. Prier Products, Inc.

i. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASME A112.6.3.

3. Pattern: Floor drain.

4. Body Material: Gray iron.

5. Seepage Flange: Required.

6. Clamping Device: Required.

7. Outlet: Bottom.

8. Coating on Interior and Exposed Exterior Surfaces: Acid resistant enamel.

9. Top or Strainer Material: No grate top.

10. Body and Strainer Finish: Nickel bronze.

11. Depth: 10 inches.

12. Top Shape: Square.

13. Dimensions of Top or Strainer: 12 inch by 12 inch, having 28 square inches of free area, and with flat bottom strainer.

14. Top Loading Classification: Light Duty.

15. Outlet Connection: Gray iron, with spigot outlet.

2.05 **TRENCH DRAINS**

A. Modular Cast-Iron Trench Drains (TD-1):

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

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2810 Series.

d. Tyler Pipe; Wade Div.

e. Watts Drainage Products Inc.

f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3 for trench drains.

3. Material: Cast iron or ductile iron.

4. Flange: Anchor.

5. Clamping Device: Not required.

6. Outlet: Bottom unless otherwise indicated.

7. Grate Material: Cast iron.

8. Grate Finish: Not required.

9. Dimensions of Frame and Grate: 6 inches wide, and length indicated on Drawings.
10. Top Loading Classification: Heavy Duty.
11. Extension Sections: As required to suit project.

B. Modular Cast-Iron Trench Drains (TD-2):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3 for trench drains.
3. Material: Cast iron or ductile iron.
4. Flange: Anchor.
5. Clamping Device: Not required.
6. Outlet: Bottom unless otherwise indicated.
7. Grate Material: Nickel bronze.
8. Grate Finish: Not required.
9. Dimensions of Frame and Grate: 6 inches wide, and length indicated on Drawings.
10. Top Loading Classification: Light Duty.
11. Extension Sections: As required to suit project.

C. Trench Drain, (TD-3):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.; Z874-12
2. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
   a. Channel Sections: Interlocking-joint, HDPE modular units, with end caps. Include flat, rounded, bottom, with sloped-invert, and with outlets in number, sizes, and locations indicated.
      1) Dimensions: 12 inches wide. Include number of units required to form total lengths indicated.

b. Frame Materials: Powder coated carbon steel.

c. Grates: Stainless steel with slots or perforations and widths and thickness that fit recesses in channel sections, and including construction covers.

d. Supports, Anchors, and Setting Devices: (10) 4” long concrete anchors per 80” section.

e. Outlet: 4” No hub bottom outlet.

f. Rebar Clips: Required.

g. Vandal Proof Lockdown Grate: Required.

h. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

i. Bottom Dome Strainer: Required.

2.06 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

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

a. Ayrlett, LLC.

b. Durgo, Inc.

c. Oatey.

d. ProSet Systems Inc.

e. RectorSeal.

f. Studor, Inc.

2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.

3. Housing: Plastic.

4. Operation: Mechanical sealing diaphragm.

5. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

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

a. Durgo, Inc.

b. Oatey.

c. Studor, Inc.

2. Standard: ASSE 1050 for vent stacks.

3. Housing: Plastic.

4. Operation: Mechanical sealing diaphragm.

5. Size: Same as connected stack vent or vent stack.

C. Wall Box:

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

a. Durgo, Inc.

b. Oatey.

c. RectorSeal.

d. Studor, Inc.

2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.

3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.07 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company; Elmdor/Stoneman Div.

b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly consisting of metal flashing collar and skirt extending at least 8 inches from pipe, with boot reinforcement and counterflashing fitting.

2.08 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:

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

a. Smith, Jay R. Mfg. Co.; Quad Close Trap Seal Device Fig. 2692.

b. SureSeal Manufacturing; Inline Floor Drain Trap Sealer.

2. Standard: ASSE 1072-2007.

3. Sealing Element: Neoprene rubber or chemically resistant elastomer.

4. Size: 2 inch, 3 inch, 3-1/2 inch, or 4 inch.

5. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

2.09 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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

a. ProSet Systems Inc.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.

3. Size: Same as connected soil, waste, or vent stack.

4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

6. Special Coating: Corrosion resistant on interior of fittings.

2.10 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Hub Outlets:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.11 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.12 **OIL SEPARATORS**

A. Oil Interceptors (OS-1):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Highland Tank & Manufacturing Co., Inc.
    b. Josam Company; Josam Div.
    c. MIFAB, Inc.
    d. Rockford Sanitary Systems, Inc.
    e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    f. Striem (OS-75 Basis of Design).
    g. Tyler Pipe; Wade Div.
    h. Watts Drainage Products Inc.
    i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Type: Factory-fabricated interceptor for separating and removing light oil from wastewater.
3. Body Material: Cast iron, steel, or polypropylene.
4. Interior Lining: Corrosion-resistant enamel for cast iron or steel bodies. Not required for polypropylene bodies.
5. Exterior Coating: Corrosion-resistant enamel for cast iron or steel bodies. Not required for polypropylene bodies.
6. Size and Capacities: 4-inch connections, 75 GPM, 110 gallon capacity.
7. Cleanout: Integral or field installed on outlet.
8. Mounting: Recessed, flush with floor.

PART 3 EXECUTION

3.01 **CONCRETE BASES**

A. Anchor grease interceptors to concrete bases.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 19-inch centers around full perimeter of base.
2. For installed equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Concrete base construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

6. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.02 **INSTALLATION**

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.

b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

G. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

J. Install vent caps on each vent pipe passing through roof.

K. Install manufactured, gray-iron downspout boots at grade with top 12 inches above grade. Secure to building wall.

L. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

M. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.

2. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

N. Install wood-blocking reinforcement for wall-mounting-type specialties.

O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

P. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.03 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Grease interceptors.

2. Solids interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 20 Section "Mechanical Identification."

3.05 **FIELD QUALITY CONTROL**

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled grease removal devices and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.06 **PROTECTION**

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.07 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain grease removal devices. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 22 1413 - STORM DRAINAGE PIPING

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section “Drainage Piping Specialties.”
4. Division 33 Section “Storm Utility Drainage Piping” for piping outside building.

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

E. TPE: Thermoplastic elastomer.

1.03 SYSTEMS DESCRIPTIONS

A. Storm drainage piping system materials are scheduled on the Drawing.

1.04 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:

1. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

C. Field quality-control inspection and test reports.

1.05 **QUALITY ASSURANCE**

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).

C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with ”NSF-dwv” for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **HUBLESS CAST-IRON SOIL PIPE AND FITTINGS**

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers:

a. ANACO-Husky; McWane Plumbing Group.

b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).

c. IDEAL-TRIDON.

d. Mission Rubber Company; a division of MCP Industries, Inc.

e. Tyler Pipe; McWane Plumbing Group.

2. Standards: CISPI 310.

3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers:

a. ANACO-Husky; McWane Plumbing Group; SD 4000.

b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).

c. IDEAL-TRIDON; Heavy-Duty “HD” No-Hub Couplings.

d. Norma Group; Clamp-All Products; HI-TORQ 125.

2. Standards: ASTM C 1277 and ASTM C 1540, or ASTM C 1277 and FM 1680 Class I.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.03 **SPECIAL PIPE FITTINGS**

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:
    a. Dallas Specialty & Mfg. Co.
    b. Fernco, Inc.
    c. Logan Clay Products Company (The).
    d. Mission Rubber Co.
    e. NDS, Inc.
    f. Plastic Oddities, Inc.
2. Sleeve Materials:
    a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
    b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Mission Rubber Co.

C. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Dresser, Inc.; DMD Div.
    c. EBAA Iron Sales, Inc.
    d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
    e. JCM Industries, Inc.
    f. Romac Industries, Inc.
    g. Smith-Blair, Inc.
    h. Viking Johnson.
2. Center-Sleeve Material: Manufacturer's standard.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
1. Manufacturers:
    a. SIGMA Corp.

PART 3 EXECUTION

3.01 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.02 **PIPING SYSTEM INSTALLATION**

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Drainage."

B. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Drainage Piping Specialties."

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."

F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

G. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

H. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.

2. Horizontal Storm-Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.

J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

K. Install underground PVC storm drainage piping according to ASTM D 2321.

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.03 **JOINT CONSTRUCTION**

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.04 **VALVE INSTALLATION**

A. General valve installation requirements are specified in Division 20 Section "Valves."

B. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.

2. Install backwater valves in accessible locations.

3. Backwater valves are specified in Division 22 Section "Drainage Piping Specialties."

3.05 **HANGER AND SUPPORT INSTALLATION**

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 **CONNECTIONS**

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.07 **FIELD QUALITY CONTROL**

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

3.08 **CLEANING**

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 1429 - SUMP PUMPS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section “Sewage Pumps” for applications in sanitary drainage systems.

1.02 SUMMARY

A. This Section includes sump pumps and accessories, inside the building, for building storm drainage systems.

1.03 ACTION SUBMITTALS

A. Product Data: For each type and size of sump pump specified, include certified performance curves with operating points plotted on curves, rated capacities of selected models, furnished specialties, and accessories.

1.04 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each sump pump to include in operation and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sump pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

1.07 **DELIVERY, STORAGE, AND HANDLING**

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.08 **COORDINATION**

A. Coordinate size and location of concrete basins. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **SUBMERSIBLE ELEVATOR SUMP PIT PUMPS**

A. Manufacturers:

1. ABS Pumps, Inc.
2. Bell & Gossett; Xylem Inc.
3. Crane Pumps and Systems; Barnes.
4. EBARA International Corporation; Standard Pump Division.
5. Goulds Pumps; Xylem Inc.
6. Gorman-Rupp Company (The).
7. Grundfos Pumps Corporation.
8. Hydromatic.
9. Little Giant Pump Co.
10. Metropolitan Industries, Inc.
11. Stancor, Inc.
12. Weil Pump Company, Inc.
13. Zoeller Company.

B. Description: Factory-assembled and -tested, simplex, single-stage, centrifugal, end-suction, submersible, direct-connected sump pumps complying with UL 778 and Hydraulic Institute HI 1.1-1.2 and HI 1.3 for submersible sump pumps.

C. Casing: Cast iron; with cast-iron inlet strainer, or stainless steel; with stainless-steel inlet strainer; legs that elevate pump to permit flow into impeller, and vertical discharge connection suitable for piping.

D. Impeller: Hardened 17-4ph stainless steel, or ASTM A 532/A 532M, abrasion-resistant cast iron; statically and dynamically balanced, semi-open non-clog design, overhung, single suction, keyed and secured to shaft.

E. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings and mechanical seals constructed of silicon carbide.

F. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection; three-conductor waterproof power cable of length required, and with grounding plug and cable-sealing assembly for connection at pump. Comply with requirements in Division 20 Section "Motors."

1. Moisture-Sensing Probe: Internal moisture sensor with moisture alarm.

G. Pump Discharge Piping: Factory or field fabricated. Refer to Division 22 Section “Sanitary Waste and Vent Piping.”

H. Basin or Pit Cover: Fiberglass grating, or cast iron or steel grating with bituminous coating.

I. Controls:

1. Electrical Characteristics: 115 volts, single phase.

2.03 SUMP PUMP BASINS

A. Manufacturer: Sump pump and basin are to be provided by the same manufacturer.

B. Description: Factory fabricated basin with sump, pipe connections, and separate cover.

C. Sump: Fabricate watertight, with sidewall openings for pipe connections.

1. Material: Fiberglass.

2. Reinforcement: Mounting plates for pumps, fittings, and accessories.

3. Anchor Flange: Same material as or compatible with sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

D. Cover: Fabricate with openings having gaskets, seals, and bushings, for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Material: Cast iron or steel.

2. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

E. Capacity and Characteristics:

1. Refer to Drawings for capacity and characteristics.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.02 CONCRETE

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 20 Section "Basic Mechanical Materials and Methods."

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.03 SUMP PUMP INSTALLATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earthwork."

B. Install sump pumps according to applicable requirements in Hydraulic Institute HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Suspend wet-pit-mounted, vertical sump pumps from basin covers. Make direct connections to storm drainage piping.

E. Set submersible sump pumps on basin floor. Make direct connections to storm drainage piping.

F. Install sump pump basins and connect to drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

G. Support piping so weight of piping is not supported by pumps.

3.04 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to sump pumps to allow service and maintenance.

C. Connect storm drainage piping to pumps. Install discharge piping equal to pump discharge connection size. If pump discharge connection size is different from storm drainage piping size, provide transition from pump discharge piping size to storm drainage piping size. Refer to Division 22 Section “Storm Drainage Piping.”

1. Install flexible connectors adjacent to pumps in discharge piping.

2. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping. Refer to Division 20 Section "Valves" for general-duty valves for drainage piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Verify bearing lubrication.

3. Disconnect couplings and check motors for proper direction of rotation.

4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

B. Start pumps without exceeding safe motor power:

1. Start motors.

2. Open discharge valves slowly.

3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.

1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.

2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.06 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 20 Section "Mechanical General Requirements."

END OF SECTION

SECTION 22 3300 - ELECTRIC DOMESTIC WATER HEATERS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.02 ACTION SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

1.03 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Detail water heater assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

B. Product Certificates: For each type of electric water heater, signed by product manufacturer.

C. Source quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For electric water heaters to include in operation and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:

1. ASHRAE 90.1, “Energy Efficient Design of New Buildings except Low-Rise Residential Buildings,” for commercial water heaters.

F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.06 **COORDINATION**

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **COMMERCIAL ELECTRIC WATER HEATERS**

A. Commercial Electric Booster Heaters: Comply with UL 1453 requirements for booster-type water heaters.

1. Manufacturers:

a. Bradford White Corporation.

b. Lochinvar Corporation.

c. Smith, A. O. Water Products Company; Gold Xi Series and Dura-Power CMC and SU Series.

d. Bock Water Heaters, Inc.

2. Storage-Tank Construction: Corrosion-resistant metal or steel.

a. Tappings: ASME B1.20.1 pipe thread.

b. Pressure Rating: 150 psig.

c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

3. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.

b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

c. Insulation: Comply with ASHRAE/IESNA 90.1.

d. Jacket: Rectangular shaped, with stainless-steel front panel, unless otherwise indicated.

e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.

1) Option: Booster heaters with 9 kW or less total may have 2 or 3 elements.

2) Staging: Input not exceeding 18 kW per step.

f. Temperature Control: Adjustable thermostat, to setting of at least 180 deg F.

g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.

h. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, combination temperature and pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

i. Gages: Combination temperature and pressure type or separate thermometer and pressure gage.

4. Capacity and Characteristics:

a. Refer to Schedule on Drawings.

2.03 EXPANSION TANKS

A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.

1. Manufacturers:

a. AMTROL Inc.

b. Armstrong Pumps, Inc.

c. Bell & Gossett; Xylem Inc.

d. Taco, Inc.

e. Wessels Co.

2. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.

b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics:

a. Refer to Schedule on Drawings.

2.04 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

C. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

2.05 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 EXECUTION

3.01 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.

1. Concrete base construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 20 Section "Valves" for hose-end drain valves.

E. Install thermometer on outlet piping of water heaters. Refer to Division 20 Section "Meters and Gages" for thermometers.

F. Install pressure gage(s) on outlet of commercial electric water- heater piping. Refer to Division 20 Section "Meters and Gages" for pressure gages.

G. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

H. Fill water heaters with water.

I. Charge compression tanks with air.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, confirm proper operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove water heaters that do not pass tests and inspections. Replace with water heaters meeting Contract requirements and retest as specified above.

3.04 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters.

END OF SECTION

SECTION 22 4200 - PLUMBING FIXTURES

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section "Medical Plumbing Fixtures."
4. Division 22 Section "Emergency Plumbing Fixtures."
5. Division 22 Section "Security Plumbing Fixtures."
6. Division 22 Section "Drinking Fountains and Water Coolers."
7. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers; individual-fixture, water tempering valves; and specialty fixtures not included in this Section.
8. Division 22 Section “Drainage Piping Specialties” for floor drains, and specialty fixtures not included in this Section.

1.02 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

C. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

E. FRP: Fiberglass-reinforced plastic.

F. PMMA: Polymethyl methacrylate (acrylic) plastic.

G. PVC: Polyvinyl chloride plastic.

H. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and trim to include in operation and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.

F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Comply with applicable ANSI, ASME, ASSE, ASTM, ICC, NSF, and UL standards and other requirements specified for plumbing fixtures, trim, fittings, components, and features.

PART 2 PRODUCTS

2.01 WATER CLOSETS

A. Water Closets, WC-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. American Standard Companies, Inc.; Afwall Wall Hung Elongated Toilet.
    b. Ferguson Enterprises, Inc.; ProFlo.
    c. Kohler Co.; Kingston K-4325-0 (top supply spud)
    d. Sloan Valve Company.
    e. Zurn Plumbing Products Group; EcoVantage.
2. Description: Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
    a. Style: Flushometer valve.
        1) Bowl Type: Elongated with siphon-jet design.
        2) Supply Spud Location: Top.
        3) Design Consumption: 1.28 gal./flush or 1.6 gal./flush.
        4) Color: White.
    b. Flushometer: FV-2-1.
    c. Toilet Seat: TS-1.
    d. Fixture Support: Water-closet support combination carrier.

2.02 MANUAL WATER CLOSET FLUSHOMETERS

A. Flushometers, FV-2-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. American Standard Companies, Inc.
    b. Delany Products.
    c. Delta Faucet Company; 81T201.
    d. Kohler Co.: MACH Series.
    e. Sloan Valve Company.
    f. Zurn Plumbing Products Group.
2. Description: Flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
    a. Internal Design: Diaphragm or piston operation.
    b. Style: Exposed.

c. Inlet Size: NPS 1.

d. Trip Mechanism: Oscillating, low-force ADA compliant lever-handle actuator.

e. Consumption: 1.28 gal./flush.

f. Tailpiece Size: NPS 1-1/2 and standard length to top of bowl.

2.03 URINALS

A. Urinals, UR-1:

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

a. American Standard Companies, Inc.; Washbrook Urinal System.

b. Kohler Co.; Bardon K 4991-ETSS.

c. Sloan Valve Company.

d. Zurn Industries, Inc.; EcoVantage.

2. Description: Wall-mounting, back-outlet, ultra-low water consumption, vitreous-china fixture designed for flushometer valve operation.

a. Type: High efficiency.

b. Strainer or Trapway: Open trapway with integral trap.

c. Design Consumption: Operates in the range of 1/8 gal./flush to 1 gal./flush.

d. Color: White.

e. Supply Spud Size: NPS 3/4.

f. Supply Spud Location: Top.

g. Outlet Size: NPS 2.

h. Flushometer: FV-1-1.

i. Fixture Support: Urinal chair carrier.

2.04 MANUAL URINAL FLUSHOMETERS

A. Flushometers, FV-1-1:

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

a. American Standard Companies, Inc.

b. Delany Products.

c. Delta Faucet Company; 81T231.

d. Kohler Co.; MACH Series.

e. Sloan Valve Company.

f. Zurn Plumbing Products Group; Z6003-WS1.

2. Description: Flushometer for urinal-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

a. Internal Design: Diaphragm or piston operation.

b. Style: Exposed.

c. Inlet Size: NPS 3/4.

d. Trip Mechanism: Oscillating, low-force ADA compliant lever-handle actuator.

e. Consumption: 0.5 gal./flush.

f. Tailpiece Size: NPS 3/4 and standard length to top of fixture.

2.05 TOILET SEATS

A. Toilet Seats, TS-1:

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

a. Bemis Manufacturing Company; 1955SSC/1955SSCT.

b. Centoco Manufacturing Corp.

c. Church Seats; 295SSC/295SSCT.

d. Comfort Seats; a Jones Stephens Brand; Model Number C106SSC.

e. Ferguson Enterprises, Inc.; ProFlo PFTSCOF2000WH.

f. Olsonite Seat Company; Model 10SSC/10SSCT.

g. Plumbtech; Plumbing Technologies, LLC.

h. Sanderson Plumbing Products, Inc.; Beneke Div.

i. Zurn Plumbing Products Group; 5955STS-WH.

2. Description: Toilet seat for water-closet-type fixture.

a. Material: Molded, solid plastic.

b. Configuration: Open front without cover.

c. Size: Elongated.

d. Hinge Type: SC, self-sustaining, check.

e. Class: Standard commercial.

f. Color: White.

2.06 LAVATORIES

A. Lavatories, LAV-1:

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

a. American Standard Companies, Inc.; Lucerne Model 0355.012.

b. Ferguson Enterprises, Inc.; ProFlo PF5504.

c. Kohler Co.; K 2005 Kingston.

d. Sloan Valve Company.

e. Zurn Plumbing Products Group; Z5344.

2. Description: Accessible, wall-mounting, vitreous-china fixture.

a. Type: With contoured back and side shields.

b. Size: 20 by 18 inches rectangular.

c. Faucet Hole Punching: Three holes, 2-inch centers.

d. Color: White.

e. Faucet: LF-1.

f. Water Temperature Limiting Device: Required.

g. Drain: Grid.

h. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, 17 gage tubular brass waste to wall; and wall escutcheon.

i. Fixture Support: Lavatory with concealed arms.

2.07 LAVATORY FAUCETS

A. Lavatory Faucets, LF-1:

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

a. American Standard Companies, Inc.; Heritage Metering Faucet Model 1340.109.

b. Chicago Faucets; Model 333-765.

c. Delta Faucet Company; 87T Series.

d. Geberit Manufacturing, Inc.

e. Kohler Co.

f. Moen Commercial.

g. Speakman Company; Model S-5122.

h. T & S Brass and Bronze Works, Inc.

i. Zurn Plumbing Products Group; Z86100-XL.

2. Description: Single-control nonmixing faucet, vandal resistant, single hole with escutcheon plate for 4 inch centers.

a. Body Material: Commercial, solid brass.

b. Finish: Polished chrome plate.

c. Maximum Flow: 0.25 gal.

d. Mounting: Deck, concealed.

e. Valve Handle(s): Push button, requiring less than 5 pounds of operating force.

f. Inlet(s): NPS 1/2.

g. Spout Outlet: Vandal resistant aerator.

h. Operation: Self-closing, metering, with replaceable valve cartridge.

2.08 COUNTER-MOUNTING SINKS

A. Sinks, SK-1:

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

a. Elkay Manufacturing Co; LRAD221955.

b. Just Manufacturing Company.

2. Description: ADA, single-bowl, counter-mounting, lay-in stainless-steel sink.

a. Overall Dimensions: 22 inches left to right by 19-1/2 inches front to back.

b. Metal Thickness: 18 gage, with sound dampened underside.

c. Bowl:

1) Dimensions: 18 inches by 14 inches by 5-1/2 inches deep.

2) Drain: 3-1/2-inch grid.

d. Sink Faucet: SF-2.

e. Water Temperature Limiting Device: Required.

f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 17 gage tubular brass waste to wall; and wall escutcheon(s).

2.09 SERVICE SINKS

A. Service Sinks, SS-1:

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

a. American Standard Companies, Inc.; Florwell Cast Iron Service Sink.

b. Kohler Co.; Whitby K 6710.

c. Zurn Plumbing Products Group; Z5850.

2. Description: Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.

a. Size: 28 by 28 inches.

b. Color: White.

c. Faucet: Sink SF-1.

d. Drain: Grid with NPS 3 outlet.

2.10 SINK FAUCETS

A. Sink Faucets, SF-1:

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

a. American Standard Companies, Inc.

b. Chicago Faucets; Model 897.

c. Delta Faucet Company; Model 28C2383.

d. Ferguson Enterprises, Inc.; ProFlo PF1118.

e. Kohler Co.

f. Moen Commercial.

g. Speakman Company; SC5811-RCP-LEV-5H-WHK.

h. Symmons Industries, Inc.

i. T & S Brass and Bronze Works, Inc.

j. Zurn Plumbing Products Group.

2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. Include 5 foot rubber hose and wall mounted hose clamp.

a. Body Material: Commercial, solid brass.

b. Finish: Polished chrome plate.

c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.

d. Mixing Valve: Two handle.

e. Centers: 8 inches.

f. Mounting: Back/wall.

g. Handle(s): Lever.

h. Inlet(s): NPS 1/2.

i. Spout Type: Rigid, solid brass with wall brace and pail hook.

j. Spout Outlet: Hose thread.

k. Vacuum Breaker: Required.

l. Operation: Noncompression, manual.

B. Sink Faucets, SF-2:

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

a. American Standard Companies, Inc.

b. Chicago Faucets; No. 201-G8AE3-317AB.

c. Delta Faucet Company; Model 23C632-R7LS.

d. Kohler Co.

e. Moen Commercial.

f. Speakman Company.

g. T & S Brass and Bronze Works, Inc.

h. Zurn Plumbing Products Group; Z831C4-140.

2. Description: Sink faucet. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.

b. Finish: Polished chrome plate.

c. Mixing Valve: Two handle.

d. Centers: 8 inches.

e. Mounting: Deck.

f. Handle(s): Wrist blade, 4 inches.

g. Operation: Noncompression, manual.

h. Inlet(s): NPS 1/2.

i. Spout Type: 70-degree restricted swing gooseneck.

j. Spout Outlet: Aerator.

1) Aerator.

2) Laminar flow or plain end for patient care areas.

k. Maximum Flow Rate:

1) 1.5 gpm.

2.11 FIXTURE SUPPLIES

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

1. BrassCraft; a Masco Company.
2. McGuire Mfg. Co., Inc.
3. Any of the approved plumbing fixture manufacturers.

B. Description: Chrome-plated brass, loose-key or screwdriver angle stops with brass stems; rigid, chrome-plated copper risers; and chrome-plated wall flanges.

2.12 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers (PSG-1):

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

a. Engineered Brass Co.

b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.

c. McGuire Manufacturing Co., Inc.

d. Plumberex Specialty Products Inc.

e. TCI Products; SG-200BV.

f. TRUEBRO, Inc.

g. Zurn Plumbing Products Group; Z8946-3-NT.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.13 FIXTURE SUPPORTS

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

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water-Closet Supports:

1. Description: Combination carrier designed for wall-mounting, water-closet-type fixture. Include:

a. Single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement.

b. Faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture.

c. Cast iron nipple and coupling kit.

d. Additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:

1. Description: For wall-mounting, urinal-type fixture. Include steel uprights with feet.

2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:

1. Description: Lavatory carrier with concealed arms and tie rods for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

2. Accessible-Fixture Support: Include rectangular steel uprights.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install wall-mounting urinals with PVC-DWV piping from urinal outlet to first change in piping direction.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings. Install accessible fixtures at heights required by local codes.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Fixtures with flushometer valves, and faucets or valves with integral stops.

J. Install ASSE 1070 water-temperature limiting devices on supplies for lavatories and sinks that will be used for handwashing, and where specified. Refer to Division 20 Section “Domestic Water Piping Specialties.”

K. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

L. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

M. Install protective shielding guards PSG-1 on exposed traps and supplies of lavatories, and sinks used for hand washing.

N. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

O. Install toilet seats on water closets.

P. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

R. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

S. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

T. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.

U. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."

V. Set service basins in leveling bed of cement grout. Grout is specified in Division 20 Section "Basic Mechanical Materials and Methods."

W. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Individual water line branches, waste lines, vents, and traps for connection to individual fixtures, fixture fittings and specialties shall be in accordance with the schedule on the Drawings.

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.04 **FIELD QUALITY CONTROL**

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.05 **ADJUSTING**

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Adjust flow at laboratory faucets having serrated nozzles to prevent splashing.

E. Replace washers and seals, or cartridges of leaking and dripping faucets and stops.

3.06 **CLEANING**

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 **PROTECTION**

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 4700 - DRINKING FOUNTAINS, WATER COOLERS, AND CUSPIDORS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.02 DEFINITIONS

A. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Cast Polymer: Dense, cast-filled-polymer plastic.

C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

D. Fitting: Device that controls flow of water into or out of fixture.

E. Fixture: Drinking fountain or water cooler.

F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.

G. TDS: Total dissolved solids.

H. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.03 ACTION SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

1.04 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Diagram power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.06 **QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in the U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about fixtures for people with disabilities.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

E. AHRI Standard: Comply with AHRI's "Directory of Certified Drinking Water Coolers" for style classifications.

F. AHRI Standard: Comply with AHRI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with AHRI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

G. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 PRODUCTS

A. Water Coolers (EWC-1):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay Manufacturing Co.; LZSTL8WSSP.
   b. Halsey Taylor.
   c. Haws Corporation.
   d. Murdock Manufacturing; A Member of Morris Group International.
   e. Oasis Corporation.
   f. Sunroc Corp.
2. Description: Accessible, AHRI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult/child-mounting height with bottle filling station.
   a. Cabinet: Bilevel, stainless steel, with hinged cover for quick filter changes.
   b. Bubbler: One, flexible or elastomeric overmolded, with adjustable stream regulator, located on each cabinet deck.
   c. Control: Push bar.
   d. Supply: NPS 3/8 with isolation valve.
   e. Filter: One or more water filters complying with Filter First Act, NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
   f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
   g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.

2) Electrical Characteristics: 1/5 hp; 120-V ac; single phase; 60 Hz.

h. Bottle Filling Station: Recessed design constructed of 18 gage Type 300 series stainless steel and ABS plastic. Include:

1) Electronic sensor for no-touch activation.

2) Automatic 20-second shut-off timer.

3) 1.1 gpm flow rate

4) Anti-microbial protected plastic components.

5) Filter status indicating light.

i. Support: Refer to "Fixture Supports" Article.

2.02 **FIXTURE SUPPORTS**

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

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.; A Member of Morris Group International.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **APPLICATIONS**

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set freestanding and pedestal drinking fountains on floor.

D. Set remote water coolers on floor, unless otherwise indicated.

E. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.03 **INSTALLATION**

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing."

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.04 **CONNECTIONS**

A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.05 **FIELD QUALITY CONTROL**

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.

2. Report test results in writing.

3.06 **ADJUSTING**

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.07 **CLEANING**

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 23 0500 - COMMON WORK RESULTS FOR HVAC

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Testing, Adjusting, and Balancing.”

1.02 SUMMARY

A. This Section includes common requirements for fans and air moving equipment.

1.03 SUBMITTALS

A. Product Data: For the following:

1. Fan bearings.
2. V-belt fan drives.
3. Direct drive couplings.

1.04 QUALITY ASSURANCE

A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical

services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

B. Fan Performance Data: AMCA Standard 210.

C. Sound Power Level Ratings:

1. Ducted Fans - Rated per AMCA 301, when tested per AMCA 300.

2. Nonducted Fans - Rated in Zones at 5 feet from acoustic center of fan rated per AMCA 301, tested per AMCA 300 and converted per AMCA 302.

1.05 **ENVIRONMENTAL REQUIREMENTS**

A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 **FAN SHAFTS**

A. Fan Shafts: Ground from solid cold rolled steel, and proportioned to run at least 25 percent below the first critical speed.

2.03 **FAN POWER TRANSMISSION**

A. V-Belt Type Fan Drives: In accordance with Engineering Standard Specification for Drives Using Multiple V-Belts, sponsored by the Mechanical Power Transmission Association and the Rubber Manufacturer's Association.

B. A given manufacturer's V-belt drive, as applied to specific equipment provided under the Contract, shall conform to the equipment manufacturer's published recommendations, except as otherwise specified.

C. Base horsepower rating of drive on minimum pitch diameter of small sheave.

D. Locate belt drives outboard of bearings. Align drive and driven shafts by the four-point method.

E. Adjust belt tension in accordance with the manufacturer's recommendations.

F. Perform alignment and final belt tensioning in the presence of the Architect.

2.04 **SHEAVES**

A. Furnish sheaves of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.

B. For all constant speed fans at or above 2 inches of total static pressure, Contractor shall provide and install two sets of fixed sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after system balance is complete and shall be based on actual field conditions.

C. For all constant speed fans below 2 inches total static pressure, Contractor shall provide and install two sets of adjustable sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after the balance is complete and shall be based on actual field conditions, and selected at mid-range of the sheave.

D. Set pitch diameters of fixed pitch and adjustable or variable pitch sheaves when adjusted as specified, at not less than that recommended by NEMA Standard MG1-14.42.

E. For companion sheaves for adjustable or variable pitch drives, furnish wide groove spacing to match driving sheaves.

F. For all variable frequency controller (VFC) operated fans, contractor shall provide and install one set of fixed sheaves sized to allow full utilization of fan motor horsepower provided, with VFC at 100 percent of fan motor RPM.

2.05 V-BELT FAN DRIVES

A. Fan Drives: Multiple V-belt style with adjustable pitch driver sheaves for fans up to 2 inches of total static pressure and fixed pitch driver sheaves for fans at or above 2 inches of total static pressure and up. Sheaves shall have split, taper style bushings. Drives shall be selected for a 150 percent service factor and shall provide for adjustment of both belt tension and alignment.

B. Manufacturers:

1. Emerson Power Transmission; Browning.
2. Rockwell Automation; Dodge.
3. T.B. Wood’s Incorporated.

2.06 FAN DRIVE, SHAFT, AND COUPLING GUARDS

A. Safety Provisions: Include guards and screens for power transmission equipment, but do not negate vibration isolation provision.

B. Furnish ANSI and OSHA compliant mechanical power transmission apparatus guards except where superseded by other governing codes, and except as modified and supplemented. Requirements specified apply to all types of fans.

C. Fabricate mechanical power transmission device guards such that the completed structure is capable of withstanding a load of at least 200 pounds applied in any direction.

D. Furnish a guard enclosure for each V-belt drive, coupling, shaft, and rotating component. Secure guards in place, easily removable for maintenance. Guard fasteners used for maintenance access shall be "captive type." Locate holes on each guard for tachometer readings on both the motor and fan shafts. Fabricate guard of minimum 16 gage sheet metal with hemmed edges at openings for shafts. Weld four mounting lugs or feet of 10 gage material to the guard. Fabricate guards for couplings five inches in diameter and larger of 12 gage sheet metal. Furnish holes in mounting feet sized for suitable machine screws.

E. Centrifugal exhaust fans shall be provided with shaft seals.

2.07 BELT DRIVE GUARDS

A. Belt Guards: ANSI and OSHA compliant with provision for readily viewing belt tension and measuring shaft speeds. Guards shall be installed with quick release pins, so that removal of three to five clip pins, will allow the guard to be removed from fan housing.

B. Fabricate guards which completely enclose moving parts of the particular drive. Design and construct guards of such rigidity as to contain a belt which breaks during operation. Minimum material thickness, 16 gage sheet metal. Where ventilation is required, perforated metal shall be used for the sides. Fabricate top of solid sheet metal.

2.08 V-BELTS

A. Notched or cogged style, endless type, of Dacron reinforced elastomer construction, with cross-section to suit sheave grooves. Determine the number of V-belts from the motor horsepower to which apply the service factor to obtain the design horsepower. Determine the corrected horsepower per

belt by multiplying the nominal horsepower per belt by an arc of contact factor not greater than 0.85. Divide the design horsepower by the corrected horsepower per belt to obtain the number of belts required. In any case, furnish not less than two belts for each drive.

B. Furnish belts that have been factory or factory-authorized distributor matched and measured on a belt-matching machine. Selection by "code numbers," "sag numbers" or "match numbers" is not acceptable. Bind each belt set with wire and tag with equipment identification.

C. Manufacturers:

1. Emerson Power Transmission; Browning; AX, BX, and CX Series and 3VX and 5VX Series.

2. Rockwell Automation; Dodge; Classic Cog and Narrow Cog V-Belts.

3. T.B. Wood’s Incorporated; Classical Cog and Narrow Cog V-Belts.

2.09 V-BELT DRIVE MOTOR BASES

A. Furnish fan motors with slide or adjustable pivoted bases wherever equipment configuration permits proper installation.

B. Provide for adjustment of both belt tension and alignment.

2.10 AIR HANDLING SYSTEM BALANCING PROVISIONS

A. Provide extra sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each air handling system during air quantity balancing operations. Furnish sheaves as specified in this Section.

2.11 FLEXIBLE COUPLINGS (DIRECT DRIVE)

A. Fan shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape, in shear, or a solid mass serrated edge disc shape, made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration or end thrust.

B. Manufacturer:

1. Falk Corporation (The).

2.12 MOTOR REQUIREMENTS

A. Furnish motors in accordance with Division 20 Section “Motors.”

2.13 FAN BEARINGS

A. Bearings: Anti-friction ball or roller type with provision for self-alignment and thrust load. Made in U.S.A. with ABMA L_{10} minimum life of 200,000 hours. Use cast iron housings and dust-tight seals suitable for lubricant pressures.

1. Lubrication Provisions - Use surface ball check type supply fittings. Provide extension tubes to allow safe maintenance while equipment is operating. Provide manual or automatic pressure relief fittings to prevent overheating or seal blow-out due to excess lubricant or pressure. Arrange relief fittings opposite supply but visible for normal maintenance observation.

2. Bearings on Equipment with less than 1/2 horsepower rating or on shafts smaller than 1-3/4 inch in diameter: Permanently sealed, pre-lubricated anti-friction bearings per specified materials and ABMA L_{10} life requirements.

2.14 IDENTIFICATION

A. Nameplate: Affix metallic, corrosion-resistant data plate for each fan in a conspicuous location. Include selection point capacity conditions.

2.15 **ACCESSORIES**

A. Bird Screens: Of material to match adjacent contact construction, 1/2 inch mesh or equal expanded metal. Use on inlet or outlet of each nonducted fan.

PART 3 EXECUTION

3.01 **INSTALLATION**

A. Field Rigging: Do not negate balancing. Do not bend shaft. Use lifting eyes.

B. Install sheaves where recommended by Testing, Adjusting, and Balancing agency.

C. Refer to individual Division 23 HVAC equipment Sections for additional requirements.

END OF SECTION

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 23 Section “Common Work Results for HVAC.”

1.02 SUMMARY

A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:

1. Air Systems:
    a. Constant-volume air systems.
    b. Dual-duct systems.
    c. Variable-air-volume systems.
    d. Multizone systems.
    e. Induction-unit systems.
2. Hydronic Piping Systems:
    a. Constant-flow systems.
    b. Variable-flow systems.

c. Primary-secondary systems.

3. HVAC equipment quantitative-performance settings.

4. Laboratory fume hood airflow balancing.

5. Exhaust hood airflow balancing.

6. Existing systems TAB.

7. Verifying that automatic control devices are functioning properly.

8. Reporting results of activities and procedures specified in this Section.

B. Include rebalancing of air systems, or system portions affected by recommended sheave changes.

1.03 **DEFINITIONS**

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. AHJ: Authority having jurisdiction.

C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

F. NC: Noise criteria.

G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

H. RC: Room criteria.

I. Report Forms: Test data sheets for recording test data in logical order.

J. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

K. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

L. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.

M. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

N. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

O. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

P. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

Q. TAB: Testing, adjusting, and balancing.

R. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

S. Test: A procedure to determine quantitative performance of systems or equipment.

T. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.04 **SUBMITTALS**

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.05 **QUALITY ASSURANCE**

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. Smoke Control System Testing: Additional Qualifications: The TAB firm shall be a qualified special inspector for the smoke control systems. The TAB firm for the smoke control system shall have expertise in fire protection engineering, mechanical engineering, and certification as air balancers.

C. Approved Balancing Agencies.

1. The TAB firm selected shall be from the following list:

a. Absolut Balance Company, Inc.; South Lyon, MI.

b. Air Solutions, Inc.; Lapeer, MI.

c. Airflow Testing Inc.; Lincoln Park, MI.

d. Barmatic Inspecting Co., Inc.; Lincoln Park, MI.

e. Control Solutions, Inc.; Byron Center, MI.

f. Ener-Tech Testing; Holly, MI.

g. Enviro-Aire/Total Balance Co.; St. Clair Shores, MI.

h. International Test & Balance Inc.; Southfield, MI.

i. Quality Air Service; Portage, MI.

j. Pro-MEC Engineering Services, Inc.; Grand Ledge, MI.

k. Hi-Tech Test & Balance; Freeland, MI.

D. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the

participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
    a. Submittal distribution requirements.
    b. The Contract Documents examination report.
    c. TAB plan.
    d. Work schedule and Project-site access requirements.
    e. Coordination and cooperation of trades and subcontractors.
    f. Coordination of documentation and communication flow.

E. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

F. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." TAB firm's forms approved by Architect.

G. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

H. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.06 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.07 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.08 WARRANTY

A. National Project Performance Guarantee: If AABC standards are used, provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract

Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. Special Guarantee: If NEBB standards are used, provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

B. Examine system and equipment test reports.

C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

D. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

E. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

F. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

G. Examine strainers for clean screens and proper perforations.

H. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

J. Examine system pumps to ensure absence of entrained air in the suction piping.

K. Examine equipment for installation and for properly operating safety interlocks and controls.

L. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.

4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
2. Maximum Allowable Leakage: Leakage rates are scheduled on the Drawings.

C. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts, or use reduced scale contract documents with notations.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Cut insulation, and drill ducts for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes with neat patches, neoprene plugs, threaded plugs, or threaded twist-on metal caps, and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

F. Check air flow within intake plenums and mixing boxes of air handling units for uneven flow and temperature stratification and prepare a report with profile elevations (temperature and velocity) on each coil or filter face for Architect.

G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

H. Verify that motor starters are equipped with properly sized thermal protection.

I. Check dampers for proper position to achieve desired airflow path.

J. Check for airflow blockages.

K. Check condensate drains for proper connections and functioning.

L. Check for proper sealing of air-handling unit components.

M. Check for proper sealing of air duct system.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

   b. Measure static pressure directly at the fan outlet.

   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Select required sheave sizes and advise installing contractor to change drive sheaves accordingly. Refer to Division 23 Section “Common Work Results for HVAC” for additional requirements.

5. When existing air handling systems require rebalancing, select required sheave sizes and advise Mechanical Contractor to change drive sheaves accordingly. Refer to Division 23 Section “Common Work Results for HVAC” for additional requirements.

6. Do not recommend fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow at a point downstream from the balancing damper and adjust volume dampers until the proper airflow is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating.

5. Power factor.

6. Nameplate and measured voltage, each phase.

7. Nameplate and measured amperage, each phase.

8. Starter size.

9. Starter thermal-protection-element rating.

10. Fuse number and size.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.07 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Air handling equipment and outlets: Plus or minus 5 percent.

a. Where terminal units serve 6 or more outlets within a common room, individual outlets may vary up to plus or minus 10 percent of design flow rates if overall room supply is within plus or minus 5 percent.

2. Heating-Water Flow Rate: 0 to minus 10 percent.

3. Cooling-Water Flow Rate: 0 to plus 5 percent.

3.08 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.09 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.

2. Fan curves.

3. Manufacturers' test data.

4. Field test reports prepared by system and equipment installers.

5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.

2. Name and address of TAB firm.

3. Project name.

4. Project location.

5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports varies from indicated values.
14. Test conditions for fans and pump performance forms including the following:
    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
2. Water flow rates.
3. Terminal units.
4. Balancing stations.

F. Air-Handling Unit - Vertical Unit Ventilators Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.

g. Discharge arrangement.

h. Sheave make, size in inches, and bore.

i. Sheave dimensions, center-to-center, and amount of adjustments in inches.

j. Number of belts, make, and size.

k. Number of filters, type, and size.

2. Motor Data:

a. Make and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

g. Power factor efficiency.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Filter static-pressure differential in inches wg.

f. Preheat coil static-pressure differential in inches wg.

g. Cooling coil static-pressure differential in inches wg.

h. Heating coil static-pressure differential in inches wg.

i. Outside airflow in cfm.

j. Return airflow in cfm.

k. Outside-air damper position.

l. Return-air damper position.

m. Vortex damper position.

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.

b. Location.

c. Coil identification.

d. Capacity in Btuh.

e. Number of stages.

f. Connected volts, phase, and hertz.

g. Rated amperage.

h. Airflow rate in cfm.

i. Face area in sq. ft.

j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btuh.

b. Airflow rate in cfm.

c. Air velocity in fpm.

d. Entering-air temperature in deg F.

e. Leaving-air temperature in deg F.

f. Voltage at each connection.

g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches, and bore.

h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

a. Make and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches, and bore.

f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling unit number.

b. Location and zone.

c. Traverse air temperature in deg F.

d. Duct static pressure in inches wg.

e. Duct size in inches.

f. Duct area in sq. ft.

g. Indicated airflow rate in cfm.

h. Indicated velocity in fpm.

i. Actual airflow rate in cfm.

j. Actual average velocity in fpm.

k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.

b. Location and zone.

c. Test apparatus used.

d. Area served.

e. Air-terminal-device make.

f. Air-terminal-device number from system diagram.

g. Air-terminal-device type and model number.

h. Air-terminal-device size.

i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.

b. Air velocity in fpm.

c. Preliminary airflow rate as needed in cfm.

d. Preliminary velocity as needed in fpm.

e. Final airflow rate in cfm.

f. Final velocity in fpm.

g. Space temperature in deg F.

K. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Unit make and model number.
d. Compressor make.
e. Compressor model and serial numbers.

2. Test Data (Indicated and Actual Values):
a. Inlet-duct static pressure in inches wg.
b. Outlet-duct static pressure in inches wg.
c. Entering-air, dry-bulb temperature in deg F.
d. Leaving-air, dry-bulb temperature in deg F.
e. Condenser entering-water temperature in deg F.
f. Condenser leaving-water temperature in deg F.
g. Condenser-water temperature differential in deg F.
h. Condenser entering-water pressure in feet of head or psig.
i. Condenser leaving-water pressure in feet of head or psig.
j. Condenser-water pressure differential in feet of head or psig.
k. Control settings.
l. Voltage at each connection.
m. Amperage for each phase.
n. Kilowatt input.
o. Crankcase heater kilowatt.
p. Number of fans.
q. Condenser fan rpm.
r. Condenser fan airflow rate in cfm.
s. Condenser fan motor make, frame size, rpm, and horsepower.
t. Condenser fan motor voltage at each connection.
u. Condenser fan motor amperage for each phase.

L. Cooling Tower or Condenser Test Reports: For cooling towers or condensers, include the following:

1. Unit Data:
a. Unit identification.
b. Make and type.
c. Model and serial numbers.
d. Nominal cooling capacity in tons.
e. Water-treatment chemical feeder and chemical.
f. Number and type of fans.

g. Fan motor make, frame size, rpm, and horsepower.

h. Fan motor voltage at each connection.

i. Sheave make, size in inches, and bore.

j. Sheave dimensions, center-to-center, and amount of adjustments in inches.

k. Number of belts, make, and size.

l. Pump make and model number.

m. Pump manufacturer's serial number.

n. Pump motor make and frame size.

o. Pump motor horsepower and rpm.

2. Pump Test Data (Indicated and Actual Values):

a. Voltage at each connection.

b. Amperage for each phase.

c. Water flow rate in gpm.

3. Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.

b. Leaving-water temperature in deg F.

c. Water temperature differential in deg F.

d. Entering-water pressure in feet of head or psig.

e. Leaving-water pressure in feet of head or psig.

f. Water pressure differential in feet of head or psig.

g. Water flow rate in gpm.

h. Bleed water flow rate in gpm.

4. Air Data (Indicated and Actual Values):

a. Duct airflow rate in cfm.

b. Inlet-duct static pressure in inches wg.

c. Outlet-duct static pressure in inches wg.

d. Average entering-air, wet-bulb temperature in deg F.

e. Average leaving-air, wet-bulb temperature in deg F.

f. Ambient wet-bulb temperature in deg F.

M. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:

1. Unit Data:

a. Unit identification.

b. Location.

c. Service.

d. Make and type.

e. Model and serial numbers.

f. Ratings.

2. Steam Test Data (Indicated and Actual Values):

a. Inlet pressure in psig.

b. Condensate flow rate in lb/h.

3. Primary Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.

b. Leaving-water temperature in deg F.

c. Entering-water pressure in feet of head or psig.

d. Water pressure differential in feet of head or psig.

e. Water flow rate in gpm.

4. Secondary Water Test Data (Indicated and Actual Values):

a. Entering-water temperature in deg F.

b. Leaving-water temperature in deg F.

c. Entering-water pressure in feet of head or psig.

d. Water pressure differential in feet of head or psig.

e. Water flow rate in gpm.

N. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.

b. Location.

c. Service.

d. Make and size.

e. Model and serial numbers.

f. Water flow rate in gpm.

g. Water pressure differential in feet of head or psig.

h. Required net positive suction head in feet of head or psig.

i. Pump rpm.

j. Impeller diameter in inches.

k. Motor make and frame size.

l. Motor horsepower and rpm.

m. Voltage at each connection.

n. Amperage for each phase.

o. Full-load amperage and service factor.

p. Seal type.

2. Test Data (Indicated and Actual Values):
    a. Static head in feet of head or psig.
    b. Pump shutoff pressure in feet of head or psig.
    c. Actual impeller size in inches.
    d. Full-open flow rate in gpm.
    e. Full-open pressure in feet of head or psig.
    f. Final discharge pressure in feet of head or psig.
    g. Final suction pressure in feet of head or psig.
    h. Final total pressure in feet of head or psig.
    i. Final water flow rate in gpm.
    j. Voltage at each connection.
    k. Amperage for each phase.

O. Air-to-Air Heat-Recovery Unit Reports:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Service.
    d. Make and type.
    e. Model and serial numbers.
2. Motor Data:
    a. Make and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. If fans are an integral part of the unit, include the following for each fan:
    a. Make and type.
    b. Arrangement and size.
    c. Sheave make, size in inches, and bore.
    d. Sheave dimensions, center-to-center, and amount of adjustments in inches.
4. Test Data (Indicated and Actual Values):
    a. Total exhaust airflow rate in cfm.
    b. Purge exhaust airflow rate in cfm.
    c. Outside airflow rate in cfm.
    d. Total exhaust fan static pressure in inches wg.

e. Total outside-air fan static pressure in inches wg.

f. Pressure drop on each side of recovery wheel in inches wg.

g. Exhaust air temperature entering in deg F.

h. Exhaust air temperature leaving in deg F.

i. Outside-air temperature entering in deg F.

j. Outside-air temperature leaving in deg F.

k. Calculate sensible and total heat capacity of each airstream in MBh.

P. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.10 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

2. Randomly check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.

b. Measure water flow of at least 5 percent of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

d. Measure sound levels at two locations.

e. Measure space pressure of at least 10 percent of locations.

f. Verify that balancing devices are marked with final balance position.

g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.

2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.

3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.11 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 0933 - TEMPERATURE CONTROLS

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

3. Division 23 Section “Testing, Adjusting, and Balancing.”
4. Division 26 Section “Electrical General Requirements.”
5. Division 26 Section “Control-voltage Electrical Power Cables.”
6. Division 26 Section “Hangers and Supports for Electrical Systems.”
7. Division 26 Section “Raceways and Boxes.”

1.02 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.03 DEFINITIONS

A. BACnet: Communications open protocol for building automation system networks and control (developed by ASHRAE and documented per ANSI/ASHRAE Standard 135-2012.

B. BAS: Building Automation System

C. CAD: Computer Aided Design.

D. DDC: Direct-digital controls.

E. TC: Temperature Control.

1.04 SYSTEM DESCRIPTION

A. Temperature control building automation system consisting of direct digital control system controllers, sensors, transducers, relays, switches, data communication network, etc. and all associated control wiring and raceway systems.

B. BAS/DDC system programming, database generation. Graphic display generation accessible through Building Network Supervisory Controller or at the remote operator workstation (when applicable for project).

C. Electric thermostats, control valves, dampers, operators, control wiring, etc.

D. Gauges, indicating devices, electric and electronic control accessories, and other control system devices.

1.05 SEQUENCE OF OPERATION

A. Control sequences for HVAC systems, subsystems, and equipment are indicated on project drawings.

1.06 SUBMITTALS

A. Submit under Division 20 and 23 provisions of respective project and as supplemented in this section.

B. All control submittal requirements shall be submitted at one time with exception to control valves, automated dampers, and initial phases of work associated with fast-track projects (when required). Early submittals of control valves and automated dampers shall be incorporated with the complete temperature controls submittal.

C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Each control device labeled with setting or adjustable range of control

D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

E. Shop Drawings:

1. Shop drawings shall be done on CAD. Minimum size 11” x 17”.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
4. Details of control enclosure including panel faces and interior, including controls, instruments, terminations blocks and component labeling.
5. Written sequence of operation for each controlled system.
6. Schedule of dampers including size, leakage, and flow characteristics (Refer to Design Data).
7. Schedule of valves including leakage and flow characteristics (Refer to Design Data).
8. Complete bill of materials to identify and quantify all control components.
9. Overall system schematic showing communication trunk cabling from Building Network Supervisory Controller(s) to BAS field level controllers including component locations and wire termination details.
10. DDC controller layouts showing connected data points and LAN connections. DDC controller terminations including power supply and remote control component termination details shall be provided.
11. Point list for each DDC controller including point descriptions and addresses. This information may be incorporated with DDC controller layouts.

F. Graphic Displays: One month after TC Shop Drawing submittal, TC Contractor shall submit graphical display backgrounds for preliminary Engineer review. Concept for each floor plan, each system, each terminal unit template. Engineer understands that final representation of graphics may not be available until BAS database is established during course of construction. Thorough graphics review will be conducted by Engineer as part of the TC/BAS acceptance procedure.

G. Design Data: Provide indicated component selection and sizing criteria for the following component categories:

1. Dampers:
    a. Component tag.
    b. Equipment served/function.
    c. Overall damper size (inch width x inch height).
    d. Quantity of damper sections with respective size(s):
    e. Material and gauge of thickness.
    f. Mounting orientation (horizontal or vertical).
    g. Blade configuration (parallel or opposed)
    h. Pressure drop (in. WG).
    i. Shut-off rating/differential pressure rating (in. wg).
    j. Leakage rating (CFM/sq. ft. at 4 in. wg).
    k. Normal position (normally open, normally closed, floating).
    l. Actuator spring range (where applicable).
    m. Actuator power requirement.
    n. Actuator torque requirement.

o. Actuator quantity.

p. Damper manufacturer/model number.

q. Actuator manufacturer/model number.

H. Wall mounted temperature sensor, thermostat and/or other temperature control device cover color shall be coordinated to match color of wall mounted electrical device components and cover plates – coordinate with electrical contractor. Provide samples of available temperature control device cover colors to Architect upon request or if available temperature control device colors do not match electrical device colors so a desired color selection may be determined. Provide sample of temperature sensor / thermostat guard upon request of Architect, Engineer or Owner.

I. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

J. Submit field reports indicating operating conditions after detailed check out of systems at Date of Substantial Completion.

K. Project Record Documents: Include the following:

1. Revise Shop Drawings to reflect actual installation and operating sequences.
2. Record actual locations of control components, including control units, thermostats, and sensors.
3. Submit the electronic files for all as-built shop drawings in pdf format.

L. Software and Firmware Operational Documentation: Include the following:

1. DDC controller keypad operating instructions and DDC controller override features, where applicable.
2. Device address list.
3. Program Software Backup: On a magnetic media or compact disc, complete with data files.

M. Maintenance Manuals: Include the following:

1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
2. Keypad illustrations and step-by-step procedures indexed for each operator function, where applicable.
3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.

1.07 **REFERENCES**

A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

B. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure fittings.

C. ANSI/ASTM B32 - Solder Metal.

D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

F. ASTM B75 - Seamless Copper Tube for General Engineering Purposes.

G. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.

H. ASTM E1 - Specification for ASTM Thermometers.

I. MMC – Michigan Mechanical Code, version applicable for project.

J. NEMA DC 3 - Low-Voltage Room Thermostats.

K. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics Only.

1.08 **QUALITY ASSURANCE**

A. Installer Qualifications: An experienced installer who is a certified installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with all applicable code requirements for project.

1.09 **DELIVERY, STORAGE, AND HANDLING**

A. Factory-Mounted Components: Where control devices specified in this Section are indicated or optional to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 **COORDINATION**

A. Coordinate work under Division 20 and 23 provisions and as supplemented in this section.

B. Coordinate location of space temperature sensors, space humidity sensor, thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

C. Coordinate installation of system components with installation of mechanical systems and equipment to achieve compatibility.

D. Ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate control wiring requirements, including actual terminal block numbers, with mechanical equipment manufacturers or suppliers.

F. Coordinate equipment with Division 26 Section "Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

G. Coordinate equipment with Division 28 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

H. Ensure control system installation is complete, checked, tested and functioning properly prior to system balancing and Owner/Engineer system checkout.

I. Cooperate fully with the Test and Balance Contractor and provide labor to operate the temperature control system as required to meet the scope of work defined in Division 23 Section "Testing, Adjusting and Balancing."

1.11 **WARRANTY**

A. Provide warranty per Division 20 Section "Mechanical General Requirements" and as supplemented in this section.

B. Provide 24 hour per day emergency service during warranty period, with maximum response period of four (4) hours. Provide phone number(s) for quick assistance by a Service Engineer regarding hardware or software problems.

C. Provide scheduled maintenance service during warranty period to inspect, calibrate, and adjust controls. Make a minimum of one four hour service call every three months. Notify Owner prior to each scheduled inspection trip. Submit written reports upon completion of service.

D. Provide any software or firmware revisions which are released by the DDC system manufacturer during the warranty period, at no additional cost to the Owner.

1.12 **POSTED OPERATING INSTRUCTIONS**

A. Provide DDC controller related as-built documents in protective binder or clear plastic display envelope for each control enclosure panel. These instructions shall include such items as as-built control diagrams and sequence of operation, simplified narrative instructions and materials necessary to aid in the operation of the equipment at the local control panels.

1.13 **SPECIAL TOOLS**

A. Deliver two sets of any special tools required for operation, adjustment, resetting or maintenance, excluding PC laptop.

1.14 **PROTECTION OF PROPRIETARY INFORMATION**

A. Non-disclosure agreement(s) that may be subject to proprietary manuals and software shall be submitted by the proprietary equipment manufacturer to the Owner for approval and signature during the warranty period.

PART 2 PRODUCTS

2.01 **DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM (BAS)**

A. The building automation system (BAS) shall be fully integrated, distributed data processing system incorporating direct digital control (DDC) for the control and monitoring of heating, ventilating and air conditioning (HVAC) equipment and other related systems. Microprocessor based BAS field level DDC controllers shall be directly connected to HVAC equipment sensors and actuators. A data communication network shall allow data exchange between the BAS field level DDC controllers and the Building Network Supervisory Controller. The Building Network Supervisory Controller shall be the primary operator BAS interface point for the building either through web-browser direct or through server application software (when applicable) or through local or remote Operator Workstation (when applicable to project).

B. Approved Manufacturer – System / Approved Installer (Locations) as listed:

1. Johnson Controls – Facility Explorer with FX Controllers / by:
    a. BASS Controls (Sterling Heights, MI).
    b. Conti Corp Controls Group. (Sterling Heights, MI).
    c. ControlNet (Swartz Creek, Kalamazoo & Grand Rapids, MI).
    d. Johnson Controls, Inc. (Auburn Hills, MI) – NOT Metasys Products.
    e. K&S Ventures, Inc. (Rochester Hills, MI).
    f. Knight Watch (Kalamazoo, Grand Rapids, Lansing & Troy, MI).
    g. Metro Controls, Inc. (Clinton Twp, MI).
    h. Michigan Environmental Controls, Inc. (New Hudson, MI).
    i. Pulse Building Services (Grand Rapids, MI).
    j. SysTemp Corporation. (Rochester Hills, MI).
    k. W.J. O'Neil Controls Group. (Livonia, MI).

2.02 **BAS BUILDING NETWORK SUPERVISORY CONTROLLER (TRIDIUM N4 PLATFORM)**

A. The Building Network Supervisory Controller, utilizing the HTML5 platform, shall provide the interface between the Owner's Ethernet and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling.

3. Trending.
4. Alarm monitoring and routing.
5. Time synchronization.
6. Integration of BACnet controller data.
7. Network Management functions for all BACnet based devices.

B. The Network Area Controller shall provide the following hardware and driver features as a minimum:
1. One RS-232 port
2. One RS-485 port with BACnet MS/TP Driver.
3. Battery Backup
4. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity).
5. Where the option for expanded memory is available, it must be supplied.

C. Provide LonWorks or MODBUS driver(s) as required for system or equipment integration requirements for project.

D. The network supervisory controller shall be sized appropriately per building to handle the required quantity of connected controllers and devices.

E. Provide 5 year service agreement per network supervisory controller for updating firmware/software as available by manufacturer. Labor for updating the controllers shall be included.

F. For Tridium based systems, provide Niagara 4 JACE-8000 series network supervisory controllers.

G. Manufacturer:
1. Manufacturers as listed for Building Automation System (based on N4 JACE-9000 platform).
2. Vykon N4 JACE-9000 series is to be used in lieu of listed manufacturer’s standard product per requirements of Owner’s existing network or as indicated on the construction drawings.

2.03 DIRECT DIGITAL CONTROL (DDC) FIELD LEVEL CONTROLLERS

A. Modular in design and consisting of stand-alone microprocessor board with ROM and fully custom programmable RAM, EPROM, and/or EEPROM memory, integral interface equipment and power surge protection. DDC controllers shall be connected directly to sensors, controlled devices and the communication network.

B. Powerfail Restart and Battery Backup: Minimum of 72 battery backup hours for complete system RAM memory and clock, with automatic battery charger or 48 hour low voltage alarm warning. Upon full system power recovery, all clocks shall be automatically synchronized, and all controlled equipment shall be automatically re-started based on correct clock time and sequence of operation.

C. Provide fully functional communication interface ports for communication between processor, other processors, portable programmer’s terminal, portable operator’s unit or the remote Operator Workstation when applicable for project.

D. Panel enclosure for controller, associated power supply and other ancillary control components shall be finished steel or rigid plastic with hinged door and keyed lock. Electronics shall be removable for protection during mounting of panel.

2.04 **DDC CONTROLLER SOFTWARE**

A. Operating system shall work in real time, provide prioritized task scheduling, control time programs, monitor DDC controller communications, scan inputs and outputs, and contain built-in diagnostics.

B. Input/output point processing shall include the following:

1. Continuous update of input and output values and/or conditions. All connected points are to be updated at least once per second.

2. Assignment of proper engineering units and status condition identifiers to all points.

3. In addition to physical or "hardware" points required, "software" points shall be provided where required for command access and meaningful displays, where required by the "execution" portion of this section or where required on the DDC input/output points lists. "Software" points shall appear identical to physical points in output displays and shall be assignable to text descriptors, logical groups, reports, etc. in the same manner as physical points. "Software" points shall be assigned alarm limits in the same manner as physical points.

C. Command control software shall manage the receipt of commands from control panels, portable programmer’s terminal, portable operator’s unit or the remote Operator Workstation when applicable for project.

1. Command delay, programmable from 0 to 2 minutes, shall be provided to prevent simultaneous energizing of large loads. Command delays shall be honored throughout the BAS DDC network, not just within the DDC controller. Delays shall be assignable on an individual per point basis.

2. Each command shall be assigned a command and residual priority to manage contentions created by multiple programs having access to the same command point. Only commands with a higher command priority than the existing residual priority shall be permitted to execute. Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority.

3. A "fixed mode" option shall be supported to allow inputs to, and outputs from DDC control programs to be set to a fixed state or value. When in the "fixed mode," inputs and outputs shall be so noted in all reports.

4. A "last user" record is to be maintained to positively identify which program or manual command is in control of a given point. The last user information shall be displayed and printed along with other point data of logical groups.

D. Provide self-test procedure. Notify remote Operator Workstation (when applicable for project) for maintenance, performance, software, cable break, or data transmission problems. Identify variables as reliable or unreliable. Variables identified as unreliable shall use default in calculation.

E. Alarm Processing

1. High/Low Alarm: Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons are to be made each scan cycle.

2. Floating Alarm: Where analog controlled values are automatically varied by software (such as hot water temperature reset), a single set of alarm limits shall be provided for those varying values. These alarm limits shall then "float" a user definable differential above and below the varying setpoint value.

3. Abnormal Alarm: When a digital input is not in agreement with the commanded state of its associated output point, or when a digital input is not in its normal state, an abnormal alarm

shall be generated. Abnormal "on" shall cause an alarm, as well as abnormal "off." Alarm time delay for digital inputs to prevent nuisance alarms shall be provided. Each digital input alarm time delay shall be adjustable from zero to two minutes in one-second increments.

4. Alarm lockout shall be provided to positively lock out alarms when equipment is turned off or when a true alarm is dependent on the condition of an associated point. Lockout points and lockout initiators shall be operator programmable. On initial startup of air handler and other mechanical equipment, a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Timed lockout period shall be programmable on a per point basis from 0 to 90 minutes in one-minute increments.

5. The capability of automatically initiating commands upon the occurrence of an alarm.

F. Totalization

1. Run time shall be accumulated based on the status of digital input points. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Run time counts shall be resident in memory and have DDC controller resident run time limits assignable through portable programmer’s terminal, portable operator’s unit or the remote Operator Workstation when applicable for project.

2. A transition counter shall be provided to accumulate the number of times a device has been cycled on or off. Counter shall be capable of accumulating 600,000 switching cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.

3. Analog totalization capability shall be provided to allow the totalization of electricity, air, water and steam flow, etc. These flows shall be totalized with respect to time and converted to the appropriate energy unit. It shall be possible to automatically set time intervals for totalization, adjustable from one second to 365 days. The totalization program shall keep track of the maximum and minimum instantaneous analog value measured during the period, including the date and time at which each occurred.

G. DDC Controller Programming / Configuration

1. All DDC controllers shall be fully programmable or configurable per required controller application type. DDC controllers which require remote or factory programming or configuration are not acceptable. DDC controllers with custom programs which may not be modified by the user are not acceptable. "Custom" programming shall mean allowing the alteration of actual control logic, and shall not be limited to allowing only the alteration of setpoints, gains, parameters, time constants, etc.

2. DDC controllers shall be provided to meet the control strategies as called for in the sequences of operation on the drawings. If a configurable application specific DDC controller cannot meet this requirement, a DDC fully programmable controller shall be provided.

3. All DDC controller setpoints, gains, parameters, time constants, etc., associated with DDC controller programs shall be available to the operator for display and modification via portable programmer’s terminal, portable operator’s unit or the remote Operator Workstation when applicable for project.

4. Each DDC controller shall have resident in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, and arithmetic, logic and relational operators for implementation of control sequences. Functions to be provided shall include, but not be limited to, the following:

   a. Mathematical: Absolute value, calculate, square root, power, sign, average, totalize.

   b. Logic: OR, AND, compare, negate.

c. Fixed Formula: High and low select, span, rate, ramp, enthalpy, wet bulb, dew point, relative humidity, humidity ratio, and filter.

d. Data Manipulation: Store, file and set.

e. Control Routines: Real-time based functions, proportional control, proportional-integral control, proportional-integral-derivative control, adaptive control (self-tuning), direct-acting, reverse acting, feedforward, fixed setpoint, calculated setpoint, adjustable setpoint, lead lag, hysteresis correction, event initiation/ software interlock.

H. Building Automation System program applications (as required for controllers)

1. Time of day scheduling: Allow the creation and maintenance of operating schedules for selected points based on time of day and holiday scheduling. At least two independent start and stop times per day for each system shall be allowed. Each point shall be allowed to have a unique time program, or points shall be able to be grouped and assigned to a common time program. Both digital and analog output points shall be able to be assigned to a time program. This software shall work in conjunction with the time of day scheduler software at the remote Operator Workstation (when applicable for project). This program shall also work in conjunction with the optimum start and optimum stop application software.

2. Optimum Start: Start equipment based on outdoor temperature, space temperature, and system response to minimize energy usage and to assure that comfort conditions are reached exactly at scheduled occupancy time (occupancy schedules are defined under "Time Of Day Scheduling"). This program shall operate in both the heating and cooling cycles. An adaptive algorithm shall be employed which automatically adjusts the start time according to previous performance and shall automatically assign longer lead times for weekend and holiday shutdowns.

3. Enthalpy Optimization: Using standard psychrometric calculations, automatically determine which air source, outdoor air or return air, presents the least total heat load, and automatically adjust mixed air damper position. When outside enthalpy exceeds return air enthalpy, the outside air damper shall go to its minimum position. Typically, the outside air damper must be in its minimum position before the cooling coil valve is allowed to open.

4. Warm-Up: Position the outside air dampers in an adjustable (minimum) position, and trigger a digital output(s) normally used to signal air terminal units to move to their maximum flow settings. When the desired space temperature is reached, as determined by feedback from space temperature sensor(s), the digital output shall return the air terminal units to their normal operation. When occupancy time is reached, the outside air dampers shall be controlled by the normal occupied mode control sequence. During the warm-up cycle, the outside air damper shall be set at the position which minimizes outside air intake while preventing over/under pressurizing of ductwork. This program shall work in conjunction with the time scheduling program and/or the optimum start program as required.

5. Night Cycle: Cycle HVAC equipment on and off as required to maintain an operator selectable unoccupied space temperature. During the equipment "on" time, the outside air damper shall be maintained in an adjustable position which minimizes outside air intake while preventing over/under pressurization of ductwork. The equipment shall be cycled such that energy reduction during unoccupied periods is uniform.

6. Night Purge: Night Purge program shall apply to cooling cycle only. Night Purge shall introduce 100% outdoor air any time the outdoor air is above 50 degrees F, the space temperature is above 75 degrees F, the outdoor air temperature is below space temperature and the outdoor air dew point is less than 60 deg F. Purging shall stop when outdoor air is below 50 deg F, or space temperature is below 75 deg F, or outdoor

temperature is less than 5 deg F cooler than space temperature, or outdoor air dew point is greater than 60 deg F.

7. Reset Optimization: Adjust equipment discharge setpoints based on one of the following criteria:

   a. By sensing the worst case requirements (e.g., the zone requiring the most heating or cooling and providing only the minimum energy required to meet the load.

   b. Adjusting the setpoint in direct proportion to another sensed variable (e.g., reset supply water temperature based on outside temperature).

2.05 DDC AIR TERMINAL UNIT CONTROLLERS

A. Microprocessor based controllers capable of stand-alone operation for control of pressure independent air terminal units. Controllers shall be networked together and connected to the building's BAS/DDC network.

B. Controllers shall have separate adjustable minimum and maximum airflow setpoints. Controllers shall work in conjunction with the air handling unit's DDC panel to provide the sequence of operation as indicated on the drawings. Setpoints shall be adjustable through the portable programmer terminal.

C. Provide electronic type air terminal unit damper operators compatible with the controller and the air terminal units provided.

D. Each controller shall have an internal differential pressure transducer capable of utilizing the total and static pressure signals from the air terminal unit's velocity sensor. Velocity sensor shall be furnished by air terminal unit manufacturer.

E. Each controller shall have electronic outputs compatible with the electronically operated air terminal unit tempering coil control valve and perimeter radiation control valve where applicable

F. TC contractor shall provide 24 VAC power requirements including transformers.

G. If coordinated with mechanical contractor. Controllers and damper operators shall be furnished to the air terminal unit manufacturer for factory mounting by the air terminal unit manufacturer; otherwise, controls shall be field installed.

H. Room temperature sensors for the DDC air terminal unit controllers:

1. Sensing Element: Thermistor or resistance temperature detector (RTD) type. Accuracy shall be+/- 0.5 degrees F over the range of 55 degrees F to 95 degrees F, including calibration error, repeatability, hysteresis, and yearly drift.

2. Cover: with tamper-proof fasteners.

3. Provide with exposed setpoint adjustment dial and exposed temperature reading.

4. Provide with exposed override switch to allow an occupant to reset the space to occupied control during the unoccupied cycle for a predetermined time period.

5. Provide with portable operator unit plug-in port.

2.06 DDC INPUT/OUTPUT SENSORS

A. Air Static/Differential Pressure Transmitters:

1. Variable capacitance type with ranges not exceeding 150 percent of maximum expected input. Transmitter shall have zero and span adjustments.

2. Safe overpressure rating shall be minimum 5 times the range.

3. Temperature compensated with thermal error of not greater than 0.04 percent of full scale in temperature range of 40 to 100 deg F.

4. Accuracy: +/- 0.5% of full scale including calibration error, repeatability, hysteresis, and yearly drift.
5. Manufacturers:
    a. Air Monitor.
    b. Belimo.
    c. Dwyer.
    d. Modus
    e. Setra.

B. Carbon Dioxide Sensors:

1. Carbon dioxide sensing cell shall consist of a nondispersive infrared carbon dioxide gas cell that uses a pulsed source and has no free air optical path. Output shall be linearized 4-20 mA with the 24 VDC input. In addition, the unit shall be capable of providing SPDT switching of an external low voltage circuit at an adjustable setpoint. The unit shall be specifically designed for the wall or duct application specified. Return air aspiration boxes shall be designed by and approved by the manufacturer. Unit shall have single point setpoint and span adjustment. The unit shall have no moving parts.
2. Power for the sensor shall be extended from a transformer or adaptor installed adjacent to the DDC controller enclosure panel, and shall be run parallel to the 4-20 mA signal cable.
3. Minimum sensing range shall be 0-2,000ppm.
4. Overall Accuracy shall be 3% of full scale including calibration error, repeatability, hysteresis and yearly drift.
5. Minimum calibration interval shall be 5 years.
6. Contractor shall provide all necessary equipment and test gas for calibration and shall calibrate all CO_2 sensors in accordance with the manufacturer’s recommendations.
7. Manufacturer:
    a. Specified BAS product where available that meets the requirements herein.
    b. Belimo.
    c. TelAire.
    d. Vaisala.
    e. Veris.

C. Current Switches:

1. Split-core or donut type transformer for monitoring AC current, with digital output signal. Current switches used on motor side of variable frequency drives shall have low frequency detection capability.
2. For Electronically Commutated Motor (ECM) applications: Current switch shall be rated for ECM operation with amperage trip setting higher than trickle/idle/standby amperage with ECM off and amperage trip setting lower than minimum speed setting. Verify minimum amperage expectation for equipment with equipment suppliers to select appropriate current switch from list of approved manufacturers as their minimum trip settings vary from 0.15A to 0.5A.
3. For induction motor applications (as applicable): Current switch shall have adjustable trip setting to accommodate VFC minimum speed settings, to detect fan belt loss, or to detect pump coupling detachment. Set trip setting at approximately 90% of normal motor operating amperage.

4. Manufacturers:
    a. ACI.
    b. Johnson Controls.
    c. Senva.
    d. Veris Industries.

D. Humidity Sensors:
1. Elements: Thin film or polymer capacitive type or bulk polymer resistance type with linear output, accurate within ± 2% RH throughout the range of 10-95% RH and drift to be less than +/-0.25%.
2. Humidity sensors shall be resistant to chlorine and other cleaning agents.
3. Room Sensors: With locking cover matching space temperature sensors used.
4. Duct Sensors: With duct probe and mounting plate.
5. Manufacturers:
    a. Specified BAS product where available that meets the requirements herein.
    b. Belimo.
    c. GE Industrial, Sensing (formerly General Eastern)
    d. Rotronic.
    e. Vaisala.
    f. Veris – HD/HO Series.

E. Outside Air Temperature/Humidity Combination Transmitters:
1. Dual transmitters housed in a single hinged enclosure with integral probes configured for exterior wall mount application with PVC sun shield. Unit shall provide separate 4-20 mA signals for temperature and humidity measurement.
2. Temperature sensor: Refer to Temperature Sensors specifications. Range of operation shall be -25 degrees F to 125 degrees F.
3. Humidity sensor: Refer to Humidity Sensors specifications. Range of operation shall be 0-100% RH.
4. Manufacturer:
    a. Belimo.
    b. Vaisala.
    c. Veris.

F. Temperature Sensors:
1. Resistance temperature detectors (RTD) with 1000 ohm, thin-filmed platinum, nickel or balco element having 0.000385 temperature coefficient meeting the input requirements of the DDC controller.
2. Thermally sensitive resistors (thermistor) shall be 10k-type, epoxy or glass coated, having NTC characteristic, meeting the input requirements of the DDC controller.
3. Initial calibration accuracy shall be +/- 0.5 deg F over the entire range. Range shall be as indicated below, or as appropriate to the application.
4. Additional error such as repeatability, stability, tolerance, linearity and hysteresis shall not exceed an additional +/- 0.5 deg F additive (using RMS method) throughout the selected operating range for the application.

5. Temperature sensors shall be resistant to chlorine and other cleaning agents
6. Single point duct mounted sensors shall have 18" rigid probe and calibrated span of 20 - 120°F.
7. Averaging duct mounted sensors shall have 25' long averaging element and calibrated span of 20 - 120°F.
8. Liquid immersion sensors shall have welded stainless steel thermowells for ferrous pipe and brass thermowells for copper pipe. Length of sensor and thermowell shall be selected based on the diameter of the pipe to provide accurate, reliable and homogeneous sensing of the liquid temperature. Thermowell pressure rating shall meet or exceed the system minimum pressure rating. Sensors for chilled water application shall have calibrated span of 20 - 120°F. Sensors for hot water applications shall have calibrated span of 40 - 240°F
9. Room sensors shall have locking cover and a minimum span of 40 - 90°F.
10. Outside air temperature (only) sensors shall have watertight inlet fitting and shall be shielded from direct rays of sun and wind.
11. Manufacturers:
    a. Specified BAS product where available that meets the requirements herein.
    b. ACI – except PT1000 averaging sensor.
    c. BAPI – Basys Series.
    d. Belimo.
    e. MAMAC
    f. Minco.
    g. TCS.

2.07 AIRFLOW MEASURING PROBES – DUCT MTD THERMAL DISPERSION (INCLUDING OA FLOW)

A. Duct airflow measuring probes shall be Thermal Dispersion type.

B. Probes shall be constructed of extruded aluminum. Probes shall be provided with mounting plate, and gasket. Probe and mounting hardware shall facilitate easy removal and reinstallation of the probes.

C. The number of sensors on each probe, and the quantity of probes provided at each location, shall comply with ASHRAE standards for duct traversing. Multiple probes provided at a single location shall be interconnected external to the duct to produce an average signal.

D. For each airflow measurement location, the measured velocity pressure shall have accuracy within ± 2% of the full scale throughout the velocity range of 0-4000 fpm.

E. Associated transmitter at each airflow measurement location shall be provided with LCD readout to indicate airflow (in CFM) of the connected airflow measuring station.

F. Manufacturers / Model:
    1. Ebtron / Gold Series.
    2. Air Monitor Corporation / ELECTRA-flo.

2.08 DDC DATA COMMUNICATIONS NETWORK

A. Data communication network shall be provided to allow data exchange between the BAS field level DDC controllers and the Building Network Supervisory Controller.

B. The BAS/DDC system-wide communication network shall consist of a primary peer-to-peer network, and at the Contractor's option, secondary sub-networks linked to the primary network.

The primary network shall support peer-to-peer communications between primary network BAS field level DDC controllers. The Building Network Supervisory Controller shall be connected to the primary network. Secondary sub-networks when used shall interface with the primary network though the primary network BAS field level DDC controllers. At least one DDC controller connected to the primary peer-to-peer network shall be provided in each mechanical room, or as indicated on the drawings.

C. Data communications media shall be twisted pair wires.

D. The communications network shall allow shared point and control information between BAS field level DDC controllers. All required repeaters, hubs, active links, gateways, etc. and associated power supplies shall be provided as required to provide shared point and control information between BAS field level DDC controllers.

E. Failure of any individual BAS field level DDC controller shall not cause the loss of communications between peer BAS field level DDC controllers.

F. All data transmitted must be positively acknowledged as received or negatively acknowledged as not received. Negative acknowledgments shall cause a retransmission of the data. Network connected devices must send a "functioning" message each network cycle. Lack of a "functioning" message after successive retries shall constitute a device failure and shall be recognized as such by the network.

G. Error recovery and communication initialization routines shall be resident in each network connected device.

2.09 CONTROL AND INSTRUMENTATION TUBING

A. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.

1. Fittings: ANSI/ASME B16.22, wrought copper.
2. Joints: ANSI/ASTM B32, 95-5 tin antimony.

B. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.

1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
2. Joints: Ball Sleeve compression type.

C. Polyethylene Tubing: Black, UL 1820 flame and smoke retardant where exposed in an air plenum, virgin polyethylene, conforming to modified ASTM D1693 test. All non-metallic tubing shall be minimum 1/4" O.D.; micro-sleeve is not acceptable.

1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
2. Joints: Compression or barbed type.

2.10 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR - AUTOMATED

A. Performance: AMCA certified for Air Performance and Air Leakage.

B. Frames: Extruded aluminum, .080-inch thickness minimum, 4 inches deep minimum, thermally broken, and insulated with polystyrene or polyurethane foam insulation.

C. Blades: Extruded aluminum, internally insulated, and thermally broken. Maximum blade size 8 inches wide, 60 inches long.

D. Shafts: Minimum 7/16 inch hexagonal or square corrosion resistant zinc plated steel.

E. Blade Seals: Extruded EPDM, silicone, or synthetic elastomeric, mechanically attached.

F. Jamb Seals: Silicone, or synthetic elastomeric, mechanically attached.

G. Bearings: Dual bearing assembly of durable synthetic polymer resulting in no metal-to-metal contact. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.

H. Linkage: Linkage shall be installed in the frame side and shall be constructed of aluminum and/or corrosion resistant zinc plated steel.

I. Leakage: Less than 3 CFM per square foot at 1 inch W.G. pressure differential at minus 40 deg F.

J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4 inches W.G.

K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.

L. Temperature Limits: Minus 40 to 155 deg F.

M. Manufacturers:

1. Greenheck ICD-45.
2. Ruskin TED50 Series.
3. Tamco Series 9000 BF.

2.11 DAMPER OPERATORS - ELECTRIC

A. Electric damper motor shall be 24 or 120 volt two-position or modulating as required with spring return type and sized to operate the damper with sufficient reserve power for smooth operation from full close to full open and tight shut-off. Damper motor shall have "O ring" gaskets for weatherproof operation.

B. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide sufficient number of operators such that one operator does not operate more than the maximum square footage of damper area as recommended in standard catalog of manufacturer.

C. Manufacturers:

1. Belimo.
2. Delta Control Products.
3. Honeywell.
4. Schneider Electric Controls.
5. Johnson Controls.
6. Siemens.

2.12 DIFFERENTIAL PRESSURE SWITCHES

A. Shall provide electrical switching action upon a sensed pressure differential increase between two sensed points. Sensitivity shall be suitable for the application. Setpoint shall be adjustable over the full range of the device. Switching action shall open or close two independent single-pole, double-throw (SPDT) switches. Electrical switch rating shall be based on the application and circuit voltage

B. Pressure rating of switch/connecting tubing and reset type:

1. Filter pressure drop - Rated for 2 inches w.g. Provide automatic reset type.
2. Duct static pressure - Rated for 10 inches w.g. Provide manual reset type when used for high limit cutout safety.

2.13 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK

A. Electrical accessories such as relays, switches, contactors and control transformers shall meet the requirements of the Division 26 Specifications of respective project.

B. Electrical wiring and conduit shall meet the requirements of the Division 26 Specifications.

C. All control wiring in mechanical rooms and any other exposed areas shall be run in conduit. Low voltage temperature control wiring in concealed accessible locations (i.e. above lay-in ceilings), as well as low voltage temperature control wiring within partitions, may be run using plenum rated cable, neatly tie-wrapped and fastened to the building structure (not to ceiling or ceiling support wires).

D. Conduits carrying control wiring shall be sized for a maximum fill of 40% of capacity.

E. Where raceway is required, two separate raceway systems shall be provided; one for A.C. wiring and the other for D.C. wiring.

F. Data transmission cabling and equipment grounding procedures shall meet the latest FCC guidelines for electromagnetic field generation.

G. All control wiring sizes and types shall meet or exceed the equipment manufacturer's recommendations.

H. TC Contractor shall provide 24V power supply transformers for TC Contractor provided controllers. Maximum Transformer circuit for controls shall be 100VA serving controllers within mechanical room control panels or for remote terminal unit controllers served from common 24V power supply circuit. Transformers shall be located within enclosures provided by TC Contractor.

2.14 LOCAL AND AUXILIARY CONTROL COMPONENT ENCLOSURE PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, pushbuttons and switches flush on cabinet panel face, or as detailed on drawings. Provide panel with locking door.

B. ANSI/NEMA 250, general purpose utility enclosures with enameled finished face panel, or as indicated on the drawings.

C. Panels shall be sized for a maximum fill of 50% capacity, and shall not be smaller than 24" X 24".

2.15 REFERENCE PROBE - DUCT STATIC PRESSURE

A. Duct static pressure probe shall be capable of static pressure measurement with bi-directional flow in a duct, plenum or air handling unit. Probe shall have minimum 4" insertion depth, shall compensate for total pressure error, and shall provide an accurate, repeatable and stable static pressure value with a maximum flow of 4000 fpm.

B. Probe shall be constructed of aluminum, with mounting flange suitable for round or flat duct surfaces. Probe shall have static pressure signal fitting.

C. Manufacturers:

1. MAMAC # A-520.
2. Dwyer # A-305.
3. Tek-Air # T-SPP 7100/7200.

2.16 REFERENCE PROBE - INDOOR STATIC PRESSURE

A. Indoor pressure reference probe shall be a shielded static pressure sensor suitable for flush mounting in the ceiling, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, control tubing take-off fitting, and brush finish on exposed surface. Probe shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 fpm from a radial source.

B. Manufacturers:

1. Air Monitor Corporation.
2. Tek-Air.

2.17 **REFERENCE PROBE - OUTDOOR STATIC PRESSURE**

A. Outdoor pressure reference probe shall be constructed of anodized aluminum, with control tubing take-off fitting, which shall be capable of sensing the outside ambient air pressure to within 2% of the actual value when subjected to radial wind velocities up to 80 miles per hour with approach angles up to 30 degrees to the horizontal.

B. Manufacturers:

1. Air Monitor Corporation.
2. Tek-Air.

2.18 **THERMOSTATS – ELECTRONIC & ELECTRIC**

A. Electronic Floating Control Room Thermostats: Microprocessor based tri-state (floating) proportional thermostat providing individual room control with setpoint adjustment, locking cover and range stops, output status LED’s, night setback/setup feature with local override switch. Manufacturer: Honeywell, Model T6984 or similar.

B. Electronic Modulating Control Room Thermostats: Microprocessor based modulating 2-10V DC thermostat providing individual room control with setpoint adjustment, locking cover and range stops, output status LED’s, night setback/setup feature with local override switch. Capable of single and dual modulating outputs to meet required control application. Manufacturer: Honeywell, Model T7984 or similar.

C. Line Voltage Room Thermostats: Adjustable single setpoint with exposed setpoint indicator and exposed thermometer for a range of 55 deg F to 85 deg F with maximum dead band of 1-1/2 degrees F, and locking cover. Contacts shall be rated for load, single-pole or two-pole as required. Provide with integral manual On/Off/Auto selector switch where indicated on control details. Power Requirement: 24 V, ac or 120 V, ac as required.

D. Room Thermostat Accessories:

1. Thermostat Covers: Manufacturers standard with finish as selected by Architect.
2. Insulating Bases: Provide one inch insulating base for thermostats located on exterior walls.
3. Adjusting Key: As required for device.

E. Electric Low Limit Duct Thermostat (freezestat): Snap acting which trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint, fixed 5 deg F differential, range 30 deg F to 60 deg F, requiring minimum 20 feet length of bulb. Manual-reset unless indicated on drawings to be auto-reset type. Provide one thermostat for every 20 sq ft of coil surface. Switch shall be UL listed and rated for 10 amps at 120 VAC. Provide additional switch or contacts for connection to monitoring system.

PART 3 EXECUTION

3.01 **INSTALLATION - CONTROL SYSTEMS**

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of temperature sensors, thermostats and other exposed control sensors with plans and room details before installation. Locate room temperature sensors and thermostats 48 inches above floor unless noted otherwise.

C. The location of all control-related items to be mounted on the exterior of the building must be approved by the Architect prior to installation. Indicate proposed locations on the shop drawings.

D. Caulk both sides of damper frames to duct walls to prevent leakage between damper frame and duct.

E. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. Sensors used for closed loop control must be connected to the same DDC controller as the associated output signal.

F. Provide conduit and electrical wiring where required.

G. All wiring in altered and unaltered areas shall be run concealed. "Wiremold" in finished areas shall be allowed when wiring cannot be run concealed in walls or partitions. Minimize “wiremold” routing.

H. Splicing of DDC sensor cabling at junction boxes shall not be acceptable.

I. All equipment which has moving parts and is remotely started by the control system shall be provided with warning labels no less than 2 inches in height, and in bright warning color, stating that the equipment is remotely started by automatic controls. Such labels shall be posted clearly in the area of any moving parts, such as belts, fans, pumps, etc.

J. Coil and conceal excess capillary on remote element instruments.

K. Install thermometers in air duct systems on flanges.

L. Install all gauges and thermometers in locations where they are easily read from normal floor level. Provide tubing or wiring as required.

M. Locate all control components and accessories such that they are easily accessible for adjustment, service and replacement.

N. Locate, size and support sensing elements in airstreams so that they properly sense the representative condition. Controlling, transmitting and indicating elements shall be located to sense the average condition. Safety elements shall be located to sense the extreme condition.

O. Locate and size sensing elements in liquid lines so that they are in moving liquid and not in stagnant or turbulent locations. Wells shall not obstruct the flow of the liquid being measured. Pipes one inch and smaller shall be increased at least one pipe size at the point of insertion.

P. Locate pressure sensing taps in liquid lines in straight runs of pipe with at least 10 pipe diameters of straight pipe both upstream and downstream of pressure tap. Provide a shut-off cock in sensing line at each pressure tap.

Q. Install pressure sensing elements in ducts and casings with clean, sharp taps to accurately read true static pressure, avoiding velocity influence and turbulence.

R. Locate, support and install all control components and accessories so that they will not be subject to vibration, excessive temperatures, dirt, moisture or other harmful conditions beyond their rated limitations.

S. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight. Provide brackets for devices to be located on insulated surfaces so as to clear the finished surface of the insulation and to avoid puncturing the vapor seal.

T. Provide all necessary relays, switches, linkages, control devices, accessories and connections as required for a complete and operational control system as specified herein and shown.

U. All electric valve and damper operators shall be capable of moving from full closed to full open, or vice versa, within 120 seconds.

3.02 **IDENTIFICATION AND MARKING**

A. All sensors, relays, switches, etc. shall be marked with the same identification number as used on the as-built shop drawings. Use Brother P-touch label maker or similar with black text on clear or white super adhesive tape. If label applied in wet environment, spray label with clear enamel for waterproofing.

B. Wire shall be color coded according to functional use. Identify color coding format on record drawings.

C. Identify each wire as to ID number at each controller termination, field device termination or on the field device.

D. All control panels and auxiliary enclosures shall be supplied with engraved phenolic nameplate permanently attached on the front exterior with panel identification to match details of temperature control submittals and include system(s) served and area(s) served on the labeling. Include labeling near 120VAC terminations within panel identifying power source panel ID and specific circuit breaker used.

3.03 **GRAPHIC DISPLAY GENERATION**

A. Provide the following graphic displays as a minimum at the operator interface, arranged in logical penetration paths:

1. Overall campus layout which shows all of the buildings on the Owner's campus.
2. Individual building layout or isometric for each building connected to the system.
3. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.
4. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
    a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
    b. System name.
    c. Area served.
    d. Present value or status of all inputs, along with present setpoint.
    e. Present percent open for each damper, valve, etc. based on commanded position.
    f. Reset schedule parameters for all points, where applicable.
    g. Present occupancy mode.
    h. Present economizer mode, where applicable.
    i. Present outside air temperature.
    j. Associated space conditions and setpoints, where applicable.
    k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
    l. Color coding to indicate normal and abnormal values, alarms, etc.
5. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc.) shall be provided. Graphic display of output point auto or manual override status shall be provided.
6. Sequence of operation in written (text) format for each HVAC system.
7. Overall BAS system schematic.
8. System management graphic for each network device and/or DDC controller.

3.04 **OWNER INSTRUCTION AND TRAINING**

A. Provide a minimum of eight (8) hours of combined on-site and classroom instruction and training to the Owner on the operation of the control systems for the initial installation.

B. Instruction and training shall be performed by a competent Contractor representative familiar with the control systems operation, maintenance and calibration.

C. Training shall take place after check, test, start-up of temperature controls system at a time mutually agreed upon by the Owner and Contractor.

3.05 **CALIBRATION AND START-UP**

A. After installation and connection of control components, test, adjust and re-adjust as required all control components in terms of function, design, systems balance and performance. Make systems ready for environmental equipment acceptance tests.

B. After environmental equipment has been accepted and after the systems have operated in normal service for two weeks, check the adjustment on control components and recalibrate where required. Components not in calibration shall be recalibrated to function as required, or shall be replaced. Control devices, linkages, and other control components shall be calibrated and adjusted for stable and accurate operation in accordance with the design intent and to obtain optimum performance from the equipment controlled. Cause every device to automatically operate as intended to ensure its proper functionality.

3.06 **ACCEPTANCE PROCEDURE**

A. Upon successful completion of start-up and recalibration as indicated in this section, the Architect shall be requested in writing to inspect the satisfactory operation of the control systems.

B. Demonstrate operation of all control systems, including each individual component, to the Owner and Architect.

C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect for inspection and approval.

D. After all items on the punch list are corrected and formal approval of the control systems is provided by the Architect, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

END OF SECTION

SECTION 23 1123 - FUEL GAS PIPING

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”

2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.02 SUMMARY

A. This Section includes facility fuel gas piping.

B. Service meters will be furnished and installed by utility company.

1.03 **DEFINITIONS**

A. Gas Main: Utility's natural gas piping.

B. Gas Distribution: Piping from gas main to individual service-meter assemblies.

C. Point of Delivery: Piping outlet from service-meter assembly.

D. Fuel Gas Piping: Piping that conveys fuel gas from point of delivery to fuel gas utilization devices inside the building.

E. PE: Polyethylene.

1.04 **PERFORMANCE REQUIREMENTS**

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: Performance requirements are scheduled on the Drawings.

2. Exception: Fuel Gas Piping Installed within Ceilings Used as Plenums: 150 psig.

1.05 **SYSTEMS DESCRIPTIONS**

A. Fuel gas piping system materials are scheduled on the Drawing.

1.06 **SUBMITTALS**

A. Product Data: For the following:

1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.

2. Service meters. Include pressure rating and capacity of selected models.

3. Pressure regulators. Include pressure rating, capacity, and settings of selected models.

B. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For natural gas specialties and accessories to include in operation and maintenance manuals.

1.07 **QUALITY ASSURANCE**

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”

B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

D. NFPA Standard: Comply with NFPA 58, “Liquefied Petroleum Gas Code.”

1.08 **DELIVERY, STORAGE, AND HANDLING**

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.09 **PROJECT CONDITIONS**

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Gas System Pressure: Not more than 5.0 psig.

C. Design values of fuel gas supplied for these systems are as follows:

1. Nominal Heating Value: 1000 Btu/cu. ft.

2. Nominal Specific Gravity: 0.6.

1.10 **COORDINATION**

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **CORRUGATED, STAINLESS-STEEL TUBING SYSTEMS**

A. Description: Comply with ANSI LC 1b/CSA 6.26b and include the following:

1. Tubing: Corrugated stainless steel with plastic jacket or coating.

2. Fittings: Copper alloy with ends made to fit corrugated tubing. Include ends with threads according to ASME B1.20.1 if connection to threaded pipe or fittings is required.

3. Striker Plates: Steel, designed to protect tubing from penetrations.

4. Manifolds: Malleable iron or steel with protective coating. Include threaded connections according to ASME B1.20.1 for pipe inlet and corrugated tubing outlets.

5. Manufacturers:

a. Titeflex Corp.

b. OmegaFlex, Inc.

c. Ward Industries, Inc.

2.03 **BLACK STEEL PIPE AND FITTINGS**

A. Black Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; Schedule 40. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.

2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.

3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.

4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.

5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.

6. Joint Compound and Tape: Suitable for natural gas.

7. Steel Flanges and Flanged Fittings: ASME B16.5.

8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.04 **POLYETHYLENE SHEATHED BLACK STEEL PIPE AND FITTINGS**

A. Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in contact with materials that may corrode the pipe.

1. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Black Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; Schedule 40. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

1. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.

2.05 **PIPING SPECIALTIES**

A. Flexible Connectors: ANSI Z21.24, copper alloy.

B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.06 **JOINING MATERIALS**

A. Refer to Division 20 Section “Basic Mechanical Materials and Methods.”

2.07 **SPECIALTY VALVES**

A. Valves, NPS 3 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 4 and Larger: Flanged ends according to ASME B16.5 for steel flanges.

C. Gas Valves, NPS 3 and Smaller: Bronze or brass body with AGA or CSA stamp, UL listed or FM approved for service, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 125-psig minimum pressure rating.

1. Manufacturers:
    a. Conbraco Industries, Inc.
    b. Crane Valves.
    c. Jomar International Ltd.
    d. Legend Valve and Fitting, Inc.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Tamperproof Feature: Include design for locking.

D. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers:
    a. Flowserve Nordstrom.
    b. Homestead Valve; a division of Olson Technologies, Inc.
    c. Milliken Valve Company.
    d. R&M Energy Systems, A Unit of Robbins & Myers, Inc.; Resun.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
8. Pressure Class: 125 psig.

2.08 SERVICE METERS

A. Turbine Meters: Axial-flow type suitable for fuel gas service. Comply with construction criteria for axial-flow, gas turbine meters in ASME MFC-4M. Include metal body, corrosion-resistant internal components, and flow registered in cubic feet. Equip meter with a pulse transmitter having an output of 1 pulse per 100 cfh.

1. Manufacturers:
    a. American Meter Company.
    b. IMAC.
    c. Sensus Metering Systems Inc.
2. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

3. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.

2.09 **PRESSURE REGULATORS**

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.

1. Manufacturers:

a. Service Pressure Regulators:

1) Elster Gas North America; Elster American Meter.

2) Fisher Controls International, Inc.; Division of Emerson Process Management.

3) Itron Gas.

b. Line Pressure Regulators:

1) Elster Gas North America; Elster American Meter.

2) Fisher Controls International, Inc.; Division of Emerson Process Management.

3) Itron Gas.

2. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

3. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.

4. Service Pressure Regulators: ANSI Z21.80. Include 100-psig- minimum inlet pressure rating.

5. Line Pressure Regulators: ANSI Z21.80 with 10-psig inlet pressure rating, unless otherwise indicated.

6. Line Pressure Regulators: ANSI Z21.80 with 2-psig- minimum inlet pressure rating.

7. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 EXECUTION

3.01 **EXCAVATION**

A. Refer to Division 31 Section “Earthwork” for excavating, trenching, and backfilling.

3.02 **EXAMINATION**

A. Examine roughing-in for fuel gas piping system to verify actual locations of piping connections before equipment installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 **PREPARATION**

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.04 **PIPING SYSTEM INSTALLATION**

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.

E. Concealed Locations:

1. Above Inaccessible Ceiling Locations: Gas piping with welded joints may be installed in inaccessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above inaccessible ceilings.

2. Above Accessible Ceiling Locations: Gas piping with welded joints may be installed in accessible ceiling spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above ceilings used as plenums.

3. In Floor Channels: Gas piping may be installed in floor channels, subject to approval of authorities having jurisdiction. Channels must have cover and be open to space above cover for ventilation.

4. Underground Beneath Building: Gas piping may be installed in protective conduit in accordance with Chapter “Gas Piping Installations” in the International Fuel Gas Code.

5. In Partitions: Do not install concealed piping in solid partitions, unless installed in a chase or casing.

   a. Exception: Piping passing through partitions or walls.

6. In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.

7. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

F. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

G. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

H. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

I. Connect branch piping from top or side of horizontal piping.

J. Install strainer on inlet of each automatic and electrically operated valve.

K. Install pressure gage upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 20 Section "Meters and Gages."

L. Locate valves for easy access.

M. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

N. Install flanges when connecting to valves, specialties, and equipment having NPS 2-1/2 and larger connections.

O. Install gas valve or plug valve and strainer upstream from each line pressure regulator or appliance pressure regulator.

P. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

Q. Install containment conduits for gas piping below slabs, within building, in gastight conduits extending minimum of 4 inches outside building, and vented to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end. Prepare and paint outside of conduits with coal-tar, epoxy-polyamide paint according to SSPC-Paint 16.

3.05 JOINT CONSTRUCTION

A. Basic piping joint construction is specified in Division 20 Section "Basic Mechanical Materials and Methods."

B. Use materials suitable for fuel gas.

C. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.06 POLYETHYLENE PIPE INSTALLATION

A. Install underground, PE, natural gas distribution piping according to ASTM D 2774.

B. Install underground, PE, natural gas distribution piping at entrance to and under part of building in steel piping protective conduit that is vented to outside.

3.07 POLYETHYLENE SHEATHED BLACK STEEL PIPE INSTALLATION

A. Provide welded assembly with welding work in accordance with ANSI B31.1, except where flanged or threaded components are provided.

B. Remove damaged polyethylene sheathing and replace with heat-shrinkable sleeves set in fresh adhesive primer.

C. Holiday Inspection:

1. Equipment: Portable, low amperage, adjustable voltage pulse-type holiday detector. Set detector operating voltage in the 8,000 to 12,000 volt range.

    a. Manufacturer:

        1) Tinker & Rasor Co.; Model AP-S2.

2. Shop Coated Pipe: Test shop coated pipe with a holiday detector before shipment.

3. Field Coated Pipe: Inspect coatings, with the exception of valves and fittings, for holidays just prior to lowering pipe in trench. Repair flaws by applying heat-shrinkable sleeves as described above. Recheck repaired surfaces for flaws with a holiday detector.

3.08 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 20 Section "Hangers and Supports."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

3.09 CONNECTIONS

A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.

B. Install piping adjacent to appliances to allow service and maintenance.

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.10 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.

1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
2. Nameplates, pipe identification, and signs are specified in Division 20 Section "Mechanical Identification."
3. Trace Wire: Yellow insulated, minimum 18 AWG wire, having copper or other approved conductor, with insulation suitable for direct burial, installed adjacent to underground nonmetallic piping, with aboveground access to tracer wire at each end of pipe.

3.11 PAINTING

A. Use materials and procedures in Division 09 painting Sections.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.
   a. Prime Coat: Alkyd anticorrosive metal primer.
   b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
   c. Topcoat: Exterior alkyd enamel
   d. Color: Gray.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03.

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.

C. Additional Testing: Subject welded fuel gas piping installed within ceiling spaces used as plenums to test pressure of 150 psig for a minimum of 2 hours.

D. Natural-gas piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 23 3113 - METAL DUCTS

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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 include the following:

1. Division 20 Section "Mechanical General Requirements."
2. Division 23 Section "Nonmetal Ducts" for fabric ducts, fibrous-glass ducts, thermoset FRP ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.02 SUMMARY

A. This Section includes metal ducts for supply, return, outside, relief air, and exhaust air-distribution systems in pressure classes from minus 6- to plus 6-inch wg.

B. Products Installed but Not Furnished Under This Section:

1. Terminal boxes which are to be furnished by the Laboratory Airflow Controls Contractor shall be installed by the Mechanical Contractor. Refer to Division 23 Section “Laboratory Airflow Controls.”

1.03 **DEFINITIONS**

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.

C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.

E. FRP: Fiberglass-reinforced plastic.

F. PVC: Polyvinyl Chloride.

1.04 **SYSTEM DESCRIPTION**

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.05 **PERFORMANCE REQUIREMENTS**

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Application Schedule" Article.

1.06 **SUBMITTALS**

A. Shop Drawings: Drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Shop drawings shall be reviewed and approved by the Architect prior to any fabrication.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation.

B. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Welding certificates.

E. Field quality-control test reports.

1.07 **QUALITY ASSURANCE**

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

1.08 **COORDINATION**

A. Sheet metal trades shall cooperate fully with the Laboratory Airflow Controls Trades and shall attend all field installation training sessions.

B. Sheet metal trades shall cooperate fully with the Test and Balance Contractor and provide all miscellaneous caps and any other materials required for structural integrity and leakage testing of the complete duct system in whole or in part. Refer to Division 23 Section "Testing, Adjusting and Balancing."

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

C. Sheet metal trades shall participate in the above ceiling coordination program. Refer to Division 01 requirements.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **SHEET METAL MATERIALS**

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on exterior sheet metal surfaces of ducts and fittings exposed to corrosive conditions and minimum 1 mil thick on interior surfaces.

D. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 4 mils thick on opposite surfaces.

E. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on interior sheet metal surfaces of ducts and fittings exposed to corrosive conditions and minimum 1 mil thick on exterior surfaces.

F. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

G. Stainless Steel: ASTM A 480/A 480M, Type 316, and having a No. 2D finish for concealed ducts and No. 4 for exposed ducts.

H. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

I. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

J. Tie Rods: For rectangular ducts having a side dimension of 48 inches or greater. Galvanized steel, 3/8-inch minimum diameter.

2.03 **DUCT LINER**

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Manufacturers:

a. CertainTeed Corp.; Insulation Group.

b. Johns Manville International, Inc.

c. Knauf Fiber Glass GmbH.

2. Materials: ASTM C 1071, Type I, flexible; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

a. Thickness: 1 inch.

b. Density: 1-1/2 pounds per cubic foot.

c. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

e. Maximum Operating Temperature: 250 deg F when tested according to ASTM C 411.

f. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

g. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.

2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.

3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

3. Noise reduction coefficient (NRC): Sound absorption coefficients shall not be less than those in the table below as tested by ASTM C423 using an ASTM E795 Type A mounting.

	Sound absorption coefficients at octave band center frequencies, Hz						
Thickness Inches	125	250	500	1000	2000	4000	NRC
1	.08	.31	.59	.84	.91	.90	.70
1-1/2	.10	.47	.83	.93	.97	.96	.80
2	.24	.64	.96	1.03	1.00	.99	.90

2.04 SEALANTS AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Elastomeric Sealant Tape: 3 inches wide; modified butyl adhesive backed.

1. Manufacturers:

a. Hardcast; Foil-Grip 1402 and Foil-Grip 1402-181BFX.

C. Water-Based Joint and Seam Sealant:

1. Manufacturers:

a. Hardcast; Flex-Grip 550 and Versa-Grip 181.

b. Polymer Adhesives; No. 11.

c. United McGill.

2. Application Method: Brush on.

3. Solids Content: Minimum 65 percent.

4. Shore A Hardness: Minimum 20.

5. Water resistant.

6. Mold and mildew resistant.

7. VOC: Maximum 75 g/L (less water).

8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Manufacturers:
   a. Hardcast; Sure-Grip 404.
   b. United McGill.
2. Application Method: Brush on.
3. Base: Synthetic rubber resin.
4. Solvent: Toluene and heptane.
5. Solids Content: Minimum 60 percent.
6. Shore A Hardness: Minimum 60.
7. Water resistant.
8. Mold and mildew resistant.
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Gaskets: Chloroprene elastomer, 40 durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.05 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
3. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
4. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

E. Load Rated Cable Suspension System for Noncorrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.

1. Cable: Aircraft quality 7 x 7 and 7 x 19 wire rope.
    a. Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
    b. Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
4. Manufacturers:
    a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
    b. Duro Dyne Corp.; Dyna-Tite System.
    c. Gripple Inc.; Hang-Fast System.

F. Stainless Steel Load Rated Cable Suspension System for Corrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.

1. Cable: Aircraft quality stainless steel 7 x 7 and 7 x 19 wire rope.
    a. Stainless steel complying with ASTM A 492.
2. Fastener: One-piece, stainless steel housing with Type 302 S26 stainless steel hardened and tempered springs, and ceramic locking wedges.
3. End Fixings:
    a. Loop End: Type 316L/A4 stainless steel.
    b. Stud or Toggle End: Type 304L/A2 stainless steel.
    c. Plain end suitable for stainless steel wire rope beam clamp.
4. Manufacturers:

a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.

b. Duro Dyne Corp.; Dyna-Tite System.

c. Gripple Inc.; Hang-Fast System.

G. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel structural support systems may be used in lieu of mill rolled structural steel.

2.06 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.

2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

3. Internal Tie Rod: Ducts having a side dimension of 48 inches or greater only.

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's and SMACNA guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:

a. Ductmate Industries, Inc.

b. Nexus Inc.

c. Ward Industries, Inc.

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.07 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.

G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

1. Fan discharges.

2. Intervals of lined duct preceding unlined duct.

3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm or where indicated.

H. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

1. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

I. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.08 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round and Flat-Oval, Spiral Lock-Seam Ducts:

1. Manufacturers:

a. Eastern Sheet Metal (ESM).

b. LaPine Metal Products.

c. Lindab Inc.

d. McGill AirFlow Corporation.

e. SEMCO Incorporated.

f. SET Duct Manufacturing, Inc.

g. Tangent Air, Inc.

h. Universal Spiral Air.

C. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA “Industrial Duct Construction Standards” as required based on pressure class.

1. Round fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

D. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA “Industrial Duct Construction Standards” as required based on pressure class.

1. Flat-oval fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

E. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.

3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.

4. Bolts and fasteners for galvanized steel duct shall be carbon steel, zinc coated per ASTM A153. Bolts and fasteners for stainless steel and polyvinyl chloride coated steel duct shall be stainless steel.

5. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

    a. Manufacturers:

        1) AccuDuct Mfg. Inc.

        2) Ductmate Industries, Inc.

        3) Eastern Sheet Metal (ESM).

        4) Lindab Inc.

        5) Universal Spiral Air.

6. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

    a. Manufacturers:

        1) AccuDuct Mfg. Inc.

        2) Ductmate Industries, Inc.

        3) Eastern Sheet Metal (ESM).

        4) McGill AirFlow Corporation.

        5) SEMCO Incorporated.

        6) Universal Spiral Air.

F. Low Pressure Ductwork (plus or minus 2 inches W.G. Static Pressure Class)

1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.

2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

G. Medium and High Pressure Ductwork (For Static Pressure Class Greater than plus or minus 2 inches W.G.)

1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.

2. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.

3. Fabricate continuously welded medium and high pressure round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

4. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

H. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

I. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

J. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
    a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
    b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
    c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
    d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
    a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
    b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
    c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
    d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
6. Round Elbows 8 Inches and Less in Diameter: Fabricate 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 nonstandard diameter elbows with gored construction.
7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
8. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
12. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

K. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.
2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.

3. Round Elbows 28 to 60 Inches in Diameter: Standard gored construction, riveted and bonded.
4. Other Fittings: Riveted and bonded joints.
5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

2.09 **DOUBLE-WALL DUCT AND FITTING FABRICATION**

A. Manufacturers:
1. Eastern Sheet Metal (ESM).
2. LaPine Metal Products.
3. Lindab Inc.
4. McGill AirFlow Corporation.
5. SEMCO Incorporated.
6. SET Duct Manufacturing, Inc.
7. Tangent Air Inc.
8. Universal Spiral Air.

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.
1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch- diameter perforations, with overall open area of 23 percent.
a. Provide 1 mil mylar liner between acoustical insulation and perforated inner liner.
4. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.
1. Solid Inner Ducts: Use the following sheet metal thicknesses:
a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.
2. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch- diameter perforations, with overall open area of 23 percent.

PART 3 EXECUTION

3.01 **DUCTWORK APPLICATION SCHEDULE**

A. Ductwork materials and performance requirements are scheduled on the Drawing.

3.02 **DUCT INSTALLATION**

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, and sleeves. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."

O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

P. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

1. Intermediate level.

3.03 **INSTALLATION OF EXPOSED DUCTWORK**

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.04 **DUCT SEALING**

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. Ducts must be properly cleaned and sealed in strict accordance with sealant manufacturer’s instructions.

1. Seal Class: Refer to Application Schedule on the Drawings.

2. Seal ducts before external insulation is applied.

3. After pressure testing, remake leaking joints until leakage is equal to or less than maximum allowable. Refer to Application Schedule on the Drawings for allowable leakage rates.

3.05 **HANGING AND SUPPORTING**

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install concrete inserts before placing concrete.

D. Support ductwork from building structure, not from roof deck, floor slab, pipe, other ducts, or equipment.

E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

F. Install roof mounted duct supports in accordance with manufacturer’s instructions. Provide additional membrane layer or walkpads under support bases as required.

G. Use load rated cable suspension system for round duct in exposed locations.

3.06 **CONNECTIONS**

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.07 **PAINTING**

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.08 **FIELD QUALITY CONTROL**

A. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

B. Duct system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.09 **START UP**

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION

SECTION 23 3119 - HVAC CASINGS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”

1.02 SUMMARY

A. Section Includes:

1. Factory or shop-fabricated, field-assembled, double-wall casings for HVAC equipment.

1.03 DEFINITIONS

A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula Btu x in./h x sq. ft. x deg F at temperature differences specified. Values are expressed as Btu.

1. Example: Apparent Thermal Conductivity (k-Value): 0.26.

1.04 PERFORMANCE REQUIREMENTS

A. Static-Pressure Classes:

1. Upstream from Fan(s): 2-inch wg.

2. Downstream from Fan(s): 2-inch wg.

B. Acoustical Performance:

1. NRC: 1.09 according to ASTM C 423.

2. STC: 40 according to ASTM E 90.

C. Structural Performance:

1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot of width.
    a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. and snow load of 30 lbf/sq. ft.

1.05 **SUBMITTALS**

A. Product Data: For factory-fabricated casings, sealant materials, and acoustic liner materials.

B. Product Certificates: For factory-fabricated casings, signed by product manufacturer.

1. Show sound-absorption coefficients in each octave band lower than those scheduled when tested according to ASTM C 423.
2. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.

C. Welding certificates.

1.06 **QUALITY ASSURANCE**

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for casing joint and seam welding.

1.07 **COORDINATION**

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate sizes and locations of steel supports. Supports are specified in Division 05 Section "Metal Fabrications."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **SHEET METAL MATERIALS**

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Exterior Surface Galvanized Coating Designation: G90.
2. Interior Surface Galvanized Coating Designation:
    a. Sections Not Exposed to Moisture: G90.
    b. Sections Housing and Downstream from Cooling Coil and Humidifiers: G90.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet steel casings.

C. Miscellaneous Materials and Products: Types and sizes required to comply with HVAC casing system requirements, including proper connection of ducts and equipment.

2.03 SEALANT MATERIALS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
7. Service: Indoor or outdoor.
8. Substrate: Compatible with galvanized sheet steel or stainless steel.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel or stainless steel.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single component, acid curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.04 GENERAL CASING FABRICATION REQUIREMENTS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 9, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

1. Fabricate casings with more than 3-inch wg negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."

2. Casings with more than 2-inch wg positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."

B. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.

2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

3. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.

4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.

5. Applied Coating Color: Standard.

C. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.

D. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Comply with requirements for escutcheons specified in Division 20 Section "Basic Mechanical Materials and Methods." Provide shaft seals where fan shafts penetrate casing.

2.05 FACTORY-FABRICATED (ACOUSTICAL PLENUM) CASINGS

A. Description: Double-wall, insulated, pressurized equipment casing.

1. Manufacturers:

a. Industrial Acoustics Company, Inc.

b. Ruskin Sound Control.

c. VAW Systems Ltd.

d. Vibro-Acoustics.

B. Panel Fabrication: Solid, galvanized sheet steel exterior shell and solid, galvanized sheet steel interior shell; with 2-inch space between shells, as indicated.

1. Fabricate with a minimum number of joints.

2. Weld exterior and interior shells to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.

3. Exterior Shell Thickness: 0.040 inch minimum.

4. Interior Shell Thickness: 0.034 inch minimum, with 3/32-inch perforations at 3/16-inch staggered spacing for 23 percent open area.

5. Fabricate perimeter and interior, longitudinal channel members with galvanized-steel shapes.

6. Fill each panel assembly with noncombustible, acoustic quality, shot-free fiberglass insulation with long, resilient fibers bonded with a thermosetting resin.

a. Density shall be as required to insure conformance with laboratory test data.

b. Fiberglass shall be packed with a minimum of 10 percent compression during casing assembly.

c. Media shall be inert, mildew resistant, and vermin proof, and comply with NFPA 90A; and resilient such that it will not crumble or break, and conform to irregular surfaces.

d. Media shall not cause or accelerate corrosion of aluminum or steel.

e. Media shall be encapsulated in Mylar to prevent shedding, erosion and impregnation of the fiberglass.

f. Mineral wool shall not be permitted as a substitute for fiberglass.

7. Fabricate panels with tongue-and-groove, continuous self-locking joints effective inside and outside each panel.

C. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.

D. Access Doors: Fabricate personnel access doors at least 24 by 60 inches and other access doors in sizes indicated.

1. Fabricate doors of same thickness as panels, with a minimum 0.040-inch solid, interior and exterior, galvanized sheet steel shell.

2. Install a minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Install doors to open against air pressure differential. Install neoprene gaskets around entire perimeters of door frames.

3. Fabricate windows in doors consisting of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install casings according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with recommended spacing of sheet metal screws and with requirements for casing sealing and trim positioning.

B. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Support components rigidly with ties, braces, brackets, and anchors of types that will maintain housing shape and prevent buckling.

D. Align casings accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.

E. Maintain duct seal class integrity throughout casings.

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

2. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.

3. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.04 **CLEANING**

A. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

1. Intermediate level.

END OF SECTION

SECTION 23 3300 - DUCT ACCESSORIES

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 23 Section “Testing, Adjusting, and Balancing” for duct test holes.
3. Division 23 Section “Temperature Controls” for motorized control dampers.
4. Division 28 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.02 DEFINITIONS

A. NVLAP: National Voluntary Laboratory Accreditation Program.

B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.

C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.

1.03 SUBMITTALS

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

1. For turning vanes, include data for pressure loss generated sound power levels.

2. For duct silencers, include pressure drop and dynamic insertion loss data.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.

b. Manual volume damper installations.

c. Control damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

e. Duct security bars.

f. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.04 **QUALITY ASSURANCE**

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.05 **EXTRA MATERIALS**

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed for each temperature rating.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **SHEET METAL MATERIALS**

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M, Types 304 and 316 as indicated.

D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

H. Tie Rods: Stainless steel, 1/4-inch diameter for lengths 36 inches or less; 3/8-inch diameter for lengths longer than 36 inches for use in ducts in humid or corrosive atmospheres.

I. Bird Screens: No. 2 mesh, 0.063 inch diameter galvanized wire screen with open area of not less than 72 percent. Conceal sharp edges by adding metal edging consisting of rod, flat or angle iron, or 16 gage galvanized sheet steel turned over at least 3/4 inch on both sides.

2.03 LOW PRESSURE MANUAL VOLUME DAMPERS

A. Manufacturers:

1. American Warming and Ventilating.
2. Arrow United Industries.
3. Greenheck.
4. Krueger.
5. Louvers and Dampers.
6. Nailor Industries Inc.
7. Ruskin Company.
8. Vent Products Company, Inc.
9. Young Regulator Company.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Except for dampers in round ductwork sized 12 inches and smaller, provide end bearings.

C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

F. Damper Materials:

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Blade Axles: Galvanized steel.
4. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
5. Tie Bars and Brackets: Galvanized steel.

G. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.04 MOTORIZED CONTROL DAMPERS

A. Refer to Division 23 Section “Temperature Controls.”

2.05 FIRE DAMPERS (CURTAIN STYLE)

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. NCA Manufacturing, Inc.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Dynamic fire dampers with curtain style blades, and labeled according to UL 555, maximum velocity 2000 fpm, maximum static pressure 4 inches w.g.

C. Fire Rating:

1. 1-1/2 hours for 2 hour rated walls.
2. 3 hours for 4 hour rated walls.

D. Frame: Type B or Type C Curtain type with blades outside airstream; fabricated with roll-formed, galvanized steel in gages required by manufacturer’s UL listing; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Fusible Links: Replaceable, 165 deg F rated.

2.06 SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. Nailor Industries Inc.
4. NCA Manufacturing, Inc.
5. Ruskin Company.

B. General Description: Smoke dampers with airfoil blades, labeled according to UL 555S, with minimum Class II leakage rating.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame and Blades: 16 gage, galvanized sheet steel.

E. Mounting Sleeve: Factory-installed, galvanized sheet steel.

1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.

F. Rated pressure and velocity to exceed design airflow conditions.

G. Damper Actuators: Electric modulating or two-position action as required.

1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

2. Size for torque required for damper seal at load conditions.

3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.

4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.

6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.

7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.

8. Actuator timing shall meet 15 sec.

9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.

H. Damper Actuators: Pneumatic modulating or two-position action.

1. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing.

2. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.

3. Actuator Degradation Temperature: Not to exceed 250 deg F.

I. Damper blade position end switches: Factory installed damper position switch package for both full open and full closed indication (equivalent to Ruskin SP100 switch package).

J. Test Switch: Damper Remote mounted momentary “test” push-button mounted 2-position “open/closed” keyed switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.

1. For pneumatic actuators, include factory installed electric/pneumatic (EP) switch for testing function.

2. Include damper remote mounted “open” and “closed” indication lights on switch plate for connection to factory installed damper blade position end switches.

2.07 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.

2. Greenheck.

3. Nailor Industries Inc.
4. NCA Manufacturing, Inc.
5. Ruskin Company.

B. General Description: Combination fire and smoke dampers shall be labeled according to UL 555 and UL 555S. Leakage shall not exceed 10 cfm per square foot at 1 inch WG differential pressure (Leakage Class II).

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating:

1. 1-1/2 hours for 2 hour rated walls.
2. 3 hours for 4 hour rated walls.

E. Smoke Detector: Integral, factory wired for single-point connection.

F. Frame and Blades: 0.064-inch- thick, galvanized sheet steel.

G. Mounting Sleeve: Factory-installed, galvanized sheet steel.

1. Thickness: Equal to or thicker than the duct connected to it, and of length to suit application.

H. Rated pressure and velocity to exceed design airflow conditions.

I. Damper Actuators: Electric modulating or two-position action as required.

1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
2. Size for torque required for damper seal at load conditions.
3. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
5. Power Requirements (Two-Position Spring Return): 24 or 120 V ac.
6. Power Requirements (Proportional): Maximum (running) 12 VA at 24-V ac or 8 W at 24-V dc. Maximum (holding) 5VA at 24-V ac or 3 W at 24-V dc holding.
7. Proportional Actuators (24V ac/dc): Control signal shall be 0-10vdc, 2-10vdc or 4-20mA as required to operate with associated controller. Include position feedback signal for 0-10vdc, 2-10vdc or 4-20mA as required to be monitored by associated controller.
8. Actuator timing shall meet 15 sec.
9. Temperature Rating: Actuator shall have a UL555S listing by the damper manufacturer for 250 deg F.

J. Damper Actuators: Pneumatic modulating or two-position action.

1. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing.
2. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
3. Actuator Degradation Temperature: Not to exceed 250 deg F.

K. Manual Heat Responsive Fuse Link with Reset and Damper Blade Position End Switches: Factory installed manual heat responsive fuse link with reset switch / damper position switch package for both full open and full closed indication (equivalent to Ruskin TS150 switch package).

L. Test Switch: Damper Remote mounted momentary “test” push-button mounted 2-position “open/closed” keyed switch rated for 24V or 120V as required to allow testing and/or maintenance of motorized dampers.

1. Include damper remote mounted “open” and “closed” indication lights on switch plate for connection to factory installed damper blade position end switches.

2.08 TURNING VANES

A. Manufactured Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane or airfoil-shaped, curved blades of galvanized sheet steel set into vane runners suitable for duct mounting.
3. Generated sound power level shall not exceed 54 decibels in octave band 4 at 2000 fpm in a 24-inch by 24-inch duct.
4. Manufacturers:
   a. Aero/Dyne Company; H-E-P Turning Vanes.
   b. Ductmate Industries, Inc.
   c. Duro Dyne Corp.
   d. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Acoustic Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane curved blades of galvanized sheet steel with perforated faces and fibrous-glass fill set into vane runners suitable for duct mounting.
3. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.09 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class. Doors may be field fabricated in accordance with SMACNA Standards, or commercially produced.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:
   a. Air Balance, Inc.
   b. Greenheck.
   c. Nailor Industries Inc.
   d. Ruskin Company.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:

a. Less Than 12 Inches Square: Secure with two sash locks.

b. Up to 18 Inches Square: Two hinges and two compression locks.

c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.

d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Manufacturers:

a. Ductmate Industries, Inc.

b. Flexmaster U.S.A., Inc.

2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.10 FLEXIBLE CONNECTORS

A. Manufacturers:

1. ADSCO Manufacturing LLC.

2. Duro Dyne Corp.

3. Senior Flexonics Pathway.

4. Ventfabrics, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.

2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.

2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

2.11 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE

A. Manufacturers:

1. Flexmaster Type 8M, UL 181, Class 1.

2. Automation Industries Thermaflex.

3. Hart & Cooley.

B. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction or fabric supported by helically wound spring steel wire or flat steel bands; rated to 6 inches WG positive and 4 inches WG negative for low and medium pressure ducts.

C. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by a fire retardant polyethylene vapor barrier jacket; maximum 0.23 K value at 75 deg F.

D. Acoustical performance tested in accordance with the Air Diffusion Council's *Flexible Air Duct Test Code FD 72-R1, Section 3.0, Sound Properties* shall be as follows:

The insertion loss (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	8	32	38	35	39	25
8" diameter	13	32	36	35	36	21
12" diameter	15	29	28	33	26	14

The radiated noise reduction (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	6	8	7	8	9	13
8" diameter	9	6	6	7	8	10
12" diameter	9	7	6	6	8	11

The self generated sound power levels (LW) dB are 10-12 Watt of a 10 foot length of straight duct for an empty sheet metal duct when tested in accordance with ASTM E477, at a velocity of 1000 feet per minute, shall not exceed:

Octave Band	2	3	4	5	6	7
Hz.	125	250	500	1000	2000	4000
6" diameter	42	31	23	18	17	21
8" diameter	41	34	27	19	18	21
12" diameter	53	44	36	27	21	22

E. Flexible Duct Fittings: Galvanized steel, twist-in design with damper. Size as indicated.

F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.12 DUCT ACCESSORY HARDWARE

A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.13 FINISHES

A. Chemical Resistant Coating: P-403 manufactured by Heresite Chemical Company.

PART 3 EXECUTION

3.01 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts and PVC coated ducts; and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers in ducts with liner in a manner that avoids damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Install fire and smoke dampers according to UL listing.

G. Install duct silencers rigidly to ducts.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. Control devices requiring inspection.
8. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Install duct-mounting, rectangular access doors with long dimension at right angles to direction of airflow and of largest standard size which can be accommodated in duct. Maximum size: 21 by 14 inches.

K. Install pressure relief doors vertically and level in accordance with manufacturer’s instructions, between the fan and first operable damper.

L. Label access doors according to Division 20 Section "Mechanical Identification."

M. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

N. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with draw bands.

R. Install flexible duct elbow supports at each diffuser, grille, or register, and elsewhere as indicated.

S. Install turning vanes in rectangular duct elbows in excess of 45 degrees, and where indicated:

1. Use manufactured double-vane turning vanes unless otherwise specified.
2. Seat outboard-most vane in heal of duct elbow.
3. Provide vanes for all runner punchings, practice of eliminating every other vane is prohibited.
4. Use single-vane turning vanes in low pressure square elbows.

3.02 **FIELD QUALITY CONTROL**

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

3.03 **ADJUSTING**

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION

SECTION 23 3423 - POWER VENTILATORS

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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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Motors.”
3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving equipment.

1.02 PERFORMANCE REQUIREMENTS

A. Classify according to AMCA 99.

1.03 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For power ventilators to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.06 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section "Roof Accessories."

1.07 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-drive unit.

PART 2 PRODUCTS

2.01 IN-LINE CENTRIFUGAL FANS

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

1. Acme Engineering & Manufacturing; Acme Fan Group.
2. Aerovent; a Twin City Fan Company.
3. Greenheck Fan Corporation; SQ-VG Series.
4. Loren Cook Company.
5. Moffitt Corporation.
6. PennBarry; Division of Air System Components.

B. Description: In-line, direct-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, EC motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Casing: Rectangular or cylindrical, flanged.

D. Throat and Mounting Assembly: One-piece spun aluminum or continuously welded assembly.

1. Stiffeners: Continuously welded.
2. Bolts, nuts, rivets, and washers: Cadmium plated.
3. Nuts: Self-locking type, vibration proof.

E. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

F. Fan Wheels: Aluminum, backward curved airfoil blades welded to aluminum hub.

G. Capacities and Characteristics: Refer to schedule(s) on Drawings.

H. Vibration Isolators: Refer to Division 20 Section “Mechanical Vibration Controls.”

2.02 DESTRATIFICATION FANS

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

1. Airius; AirPear.
2. Zoo Fans.

B. Housing: ABS.

C. Motor: ECM.

D. Accessories:

1. 6-foot steel safety cable fastened to fan body.
2. DF-F1 through DF-F6: BACnet package for integration with BMS system.
3. DF-F7 through DF-F10: Wall-mounted speed control. Low voltage control wiring to be daisy-chained between fans to be controlled as a group.

2.03 MOTORS

A. Comply with requirements in Division 20 Section "Motors."

2.04 **SOURCE QUALITY CONTROL**

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 EXECUTION

3.01 **INSTALLATION**

A. Install power ventilators level and plumb.

B. Install floor-mounting units as specified in Division 20 Section "Mechanical Vibration Controls."

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 20 Section "Mechanical Vibration Controls."

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 20 Section "Mechanical Identification."

3.02 **CONNECTIONS**

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.03 **FIELD QUALITY CONTROL**

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 **ADJUSTING**

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor sheaves as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

SECTION 23 3600 - AIR TERMINAL UNITS

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1.02 ACTION SUBMITTALS 1
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3.03 CONNECTIONS 4
3.04 FIELD QUALITY CONTROL 4
3.05 STARTUP SERVICE 4
3.06 DEMONSTRATION 4

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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 23 Section “Metal Ducts.”
3. Division 23 Section “Temperature Controls.”

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Liners and adhesives.
2. Sealants and gaskets.

1.03 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
2. Wiring Diagrams: Power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in operation and maintenance manuals. Include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.05 **QUALITY ASSURANCE**

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.06 **COORDINATION**

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **SINGLE-DUCT AIR TERMINAL UNITS**

A. Manufacturers:

1. Krueger-HVAC; Air Distribution Technologies, Inc.; a JCI Company.
2. Nailor Industries, Inc.
3. Price Industries.
4. Titus; Air Distribution Technologies, Inc.; a JCI Company.
5. Tuttle & Bailey; Air Distribution Technologies, Inc.; a JCI Company.

B. Configuration: Variable and constant volume, medium pressure terminal units with casing, 24 volt control transformer, electrical service disconnect switch, 100 percent tight shutoff volume regulator, velocity sensor, and sound attenuating thermal insulation.

C. Casing: Constructed of 0.034-inch mill galvanized steel or 0.032-inch aluminum.

1. Casing Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections, size matching inlet size.
4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

E. Velocity Sensor: Multipoint averaging array. Sensor located in air inlet.

F. Attenuator Section: 0.034-inch mill galvanized steel or 0.032-inch aluminum sheet metal.

1. Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.

G. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed. Include the following features:

1. Primary and secondary overtemperature protection.
2. Nickel chrome 80/20 heating elements.
3. Airflow switch.
4. Noninterlocking disconnect switch.
5. Fuses (for coils more than 48 A).
6. SCR power controller.
7. Pneumatic-electric switches and relays.
8. Magnetic contactor for each step of control (for three-phase coils).

H. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section "Temperature Controls."

I. Control Sequence: Refer to Temperature Control Diagrams on Drawings.

2.03 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Steel Cables: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.04 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

B. Verification of Performance: Rate air terminal units according to AHRI 880.

C. Acoustical Applications and Sound Evaluation: Based on AHRI Standard 885-98, “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.”

PART 3 EXECUTION

3.01 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.02 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached. Refer to Division 20 Section “Hangers and Supports” for additional information.

1. Where practical, install concrete inserts before placing concrete.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.03 **CONNECTIONS**

A. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

E. Ground units with electric heating coils according to Division 26 Section "Grounding and Bonding."

F. Connect wiring according to Division 26 Section "Conductors and Cables."

G. 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.

3.04 **FIELD QUALITY CONTROL**

A. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.

2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.05 **STARTUP SERVICE**

A. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.

2. Verify that controls and control enclosure are accessible.

3. Verify that control connections are complete.

4. Verify that nameplate and identification tag are visible.

5. Verify that controls respond to inputs as specified.

3.06 **DEMONSTRATION**

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

END OF SECTION

SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL 1
1.01 RELATED DOCUMENTS 1
1.02 SUBMITTALS 1
PART 2 PRODUCTS 1
2.01 AIR DIFFUSION DEVICES 1
2.02 SOURCE QUALITY CONTROL 2
PART 3 EXECUTION 2
3.01 EXAMINATION 2
3.02 INSTALLATION 2
3.03 ADJUSTING 2

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 20 Section “Mechanical General Requirements.”
3. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.02 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

PART 2 PRODUCTS

2.01 AIR DIFFUSION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Anemostat; a Mestek Company.

2. Krueger; Tomkins PLC.
3. Nailor Industries of Texas Inc.
4. Price Industries.
5. Titus; Tomkins PLC.
6. Tuttle & Bailey; Tomkins PLC.

B. Terminal air diffusion devices have been chosen in terms of specific air distribution requirements, spacing, and sound characteristics.

C. Provide plaster frames for units installed in plaster ceilings.

D. Provide gaskets for supply terminal air devices mounted in finished surfaces.

E. Air diffusion devices shall be standard off white baked enamel finish unless noted otherwise. Provide air diffusion device interior surfaces, including blank-offs, with black matte finish.

F. Air pattern adjustments shall be made from the face of the device.

G. Refer to drawings and schedules for quantities, types, and finishes.

H. Coordinate frame types with Architectural Reflected Ceiling Plan.

2.02 **SOURCE QUALITY CONTROL**

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

B. Acoustical Applications and Sound Evaluation: Based on ARI Standard 885-98, “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.”

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION**

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Wall-Mounted Supply Registers: Install 6 inches below finished ceiling unless otherwise indicated.

D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 **ADJUSTING**

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 3716 - FABRIC AIR-DISTRIBUTION DEVICES

PART 1 GENERAL 1
1.01 RELATED DOCUMENTS 1
1.02 ACTION SUBMITTALS 1
1.03 INFORMATIONAL SUBMITTALS 1
PART 2 PRODUCTS 1
2.01 MANUFACTURERS 1
2.02 FABRIC DUCTS 2
PART 3 EXECUTION 3
3.01 INSTALLATION 3
3.02 START UP 3

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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 23 Section "Metal Ducts.”

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

B. Shop Drawings: For fabric air-distribution devices.

1. Include plans, elevations, sections, and suspension and attachment details.

C. Samples for Initial Selection: For diffusers with factory-applied color finishes.

D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected.

E. Diffuser Schedule: Use same designations indicated on Drawings. Indicate room location, quantity, model number, size, and accessories furnished.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Source quality-control reports.

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

1. Ductsox Corporation.

2. KE Fibertec.
3. FabricAir, Inc.

2.02 **FABRIC DUCTS**

A. Performance Requirements: Classified by UL in accordance with the 25/50 flame spread/smoke developed requirements of NFPA 90A.

B. Material: Air diffusers shall be constructed of a woven fire retardant fabric complying with the following physical characteristics:

1. Fabric: Polyester, treated with machine wash-able anti-microbial agent by the fabric manufacturer, of a non-linting filament yarn to meet the requirements of ISO Class 3 environment, and flame retardant.
   a. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements NFPA 90, and UL 2518.
   b. Weight: 6.8 oz./sq yd in accordance with ASTM D3776
   c. Color: Custom color as selected by Architect.
   d. Fabric Porosity: 2 (+2/-1) cfm/sq ft in accordance with ASTM D737, Frazier.
   e. Temperature Range: 0 deg F to 180 deg F.
   f. Antimicrobial agent shall be proven 99 percent effective after 10 laundry cycles in accordance with AATCC Test Method 100.
2. Shape: Round.

C. System Fabrication Requirements:

1. Textile system constructed in modular lengths (zippered) with proper securing clips, inlets, end caps, and mid-sections.
2. Integrated air dispersion shall be:
   a. Linear Vents:
      1) Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on 0.5 inch static pressure), starting at 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
      2) Size of vent openings and location of linear vents to be specified and approved by manufacturer.

D. Design Requirements:

1. Designed for 0.5 inch water gage, yielding maximum operating pressure of 3.1 inches water gage.
2. Fabric diffusers limited to design temperatures between 10 deg F and 180 deg F.
3. Design cfm, static pressure, and diffuser length shall be designed or approved by manufacturer.
4. Do not use fabric diffusers in concealed locations.
5. Use fabric diffusers for positive pressure air distribution components of the mechanical ventilation system only.

E. Suspension Hardware:

1. Internal Hoop System and Extruded Track Suspension System: (Available for duct diameters from 8-inches to 60 inches). System consists of metallic internal hoops spaced 5 feet apart and attached to the interior of the fabric duct. Suspension system consists of 8 foot sections of extruded track, couplers, end caps, locking cable drop supports or surface mount clips, and gliders spaced every 24 inches. Extruded track sections bent to follow centerline radius of radius elbows as required.

PART 3 EXECUTION

3.01 INSTALLATION

A. Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

3.02 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION

SECTION 23 8121 - PACKAGED ROOFTOP AIR CONDITIONERS

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1.01 RELATED DOCUMENTS 1
1.02 SUMMARY 1
1.03 DEFINITIONS 1
1.04 ACTION SUBMITTALS 2
1.05 INFORMATIONAL SUBMITTALS 2
1.06 CLOSEOUT SUBMITTALS 2
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PART 2 PRODUCTS 3
2.01 MANUFACTURERS 3
2.02 PACKAGED ROOFTOP AIR CONDITIONING UNITS 3
PART 3 EXECUTION 8
3.01 INSTALLATION 8
3.02 CONNECTIONS 8
3.03 FIELD QUALITY CONTROL 9
3.04 STARTUP SERVICE 9
3.05 ADJUSTING 10
3.06 DEMONSTRATION 11

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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 20 Section “Mechanical Vibration Controls.”
4. Division 23 Section “Temperature Controls.”

1.02 SUMMARY

A. This Section includes outdoor-mounted air conditioning units 20 tons and larger.

B. Products supplied but not installed under this Section:

1. Roof curbs and equipment rails.

1.03 DEFINITIONS

A. DDC: Direct-digital controls.

B. BAS: Building Automation System.

C. Modulating: As applied to gas-fired heat exchangers, infinite or finely stepped regulation of burner output within a specified range.

1.04 **ACTION SUBMITTALS**

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

1.05 **INFORMATIONAL SUBMITTALS**

A. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wiring Diagrams: Power, signal, and control wiring.

1.06 **CLOSEOUT SUBMITTALS**

A. Field quality-control test reports.

B. Operation and Maintenance Data: For rooftop air conditioners to include in operation and maintenance manuals.

1.07 **QUALITY ASSURANCE**

A. AHRI Compliance:

1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

1.08 **COORDINATION**

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.09 **WARRANTY**

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of rooftop air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Not less than five years warranty on parts, from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Not less than 10 years warranty on parts, from date of Substantial Completion.

1.10 **EXTRA MATERIALS**

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-drive fan.

2. Filters: One set of filters for each unit.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 **PACKAGED ROOFTOP AIR CONDITIONING UNITS**

A. Manufacturers:

1. For single zone variable air volume (SZVAV) applications 20 tons and under:

a. AAON, Inc.; RQ/RN Series.

b. Carrier; FE/GE.

c. Daikin; DPS.

d. Greenheck; RV/RVE Series.

e. Lennox; L Series.

2. For discharge air temperature and duct static pressure variable air volume (DAT-DSP VAV) applications 20 tons and under:

a. AAON, Inc.; RQ/RN Series.

b. Carrier; JE.

c. Daikin; DPS.

d. Greenheck; RV/RVE Series.

e. Lennox; L Series.

3. For single zone variable air volume (SZVAV) applications larger than 20 tons:

a. AAON, Inc.; RZ Series.

b. Carrier; 48V/50V Series.

c. Daikin; RoofPak RPS and RDT.

d. Greenheck; RV/RVE Series.

e. Trane; IntelliPak.

f. Johnson Controls Incorporated; Premier/Sun Premier.

4. For discharge air temperature and duct static pressure variable air volume (DAT-DSP VAV) applications larger than 20 tons:

a. AAON, Inc.; RZ Series.

b. Carrier; 48V/50V Series.

c. Daikin; RoofPak.

d. Greenheck; RV/RVE Series.

e. Trane; IntelliPak.

f. Johnson Controls Incorporated; Premier/Sun Premier.

B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, condenser coils, direct expansion refrigerant coils, heat exchanger, supply-air fan, relief or exhaust fan, condenser coil fan, refrigeration controls, filters, dampers, and temperature controls or interface specified for unit controls.

C. Maximum Temperature Distribution Across Supply Air Outlet:

1. 10 deg F Heating.

2. 5 deg F Cooling.

D. Casing: Double-wall galvanized sheet metal construction with exterior enamel paint finish. Units having single-wall casing construction are not acceptable.

1. Finish able to withstand minimum 500-hour salt spray test in accordance with ASTM B117.

2. Hinged access doors with neoprene gaskets for inspection and access to internal parts.

3. Minimum 1-inch-thick thermal insulation.

4. Perforated-metal liner on supply-air fan discharge section.

5. Knockouts for electrical and piping connections.

6. Exterior condensate drain connection.

7. Lifting lugs.

E. Supply-Air Fan: Fan type and quantity as scheduled.

1. Centrifugal, direct-driven, grease-lubricated ball bearings, and electronically commutated motor or NEMA motor with variable frequency controller.

2. Fan Arrays: Refer to Division 23 Section “Fan Arrays.”

F. Relief or Exhaust Fan: Fan type and quantity as scheduled.

1. Forward Curved, or Airfoil: direct-driven, grease-lubricated ball bearings, and electronically commutated motor or NEMA motor with variable frequency controller.

2. Fan Arrays: Refer to Division 23 Section “Fan Arrays.”

G. Condenser Coil Fans: Propeller type, directly driven by permanently lubricated motor.

H. Condenser Coils: Heavy duty aluminum fins mechanically bonded to seamless copper tubes, tested to 450 psig and leak tested to 300 psig with air under water. Provide subcooling circuit(s) integral with condenser coils to maximize efficiency and prevent premature flashing of liquid refrigerant, to a gaseous state, ahead of the expansion valve. Condenser coils shall not exceed 14 fins per inch density in order to permit routine cleaning, and prevent excessive air pressure drop across the condenser coil.

I. Direct Expansion Cooling Coils: Aluminum-plate fin and seamless copper tube in stainless-steel casing inter-circuited to assure complete coil face activity, with equalizing-type vertical distributor and thermal expansion valve; tested to 450 psig and leak tested to 300 psig with air under water.

J. Hot Gas Reheat Coils: Aluminum-plate fin and seamless copper tube in stainless-steel casing inter-circuited to assure complete coil face activity.

K. Drain Pan: Under cooling coils. Formed of stainless-steel sheet and complying with requirements in ASHRAE 62.1. Fabricate pans with slopes in two planes to collect condensate from cooling coils (including coil piping connections and return bends) and when units are operating at maximum design face velocity across the coils.

1. Drain Connections: Both ends of pan.
2. Units with stacked coils shall have an intermediate stainless steel drain pan or drain trough to collect condensate from top coil.

L. Compressor(s): Hermetic scroll compressors. Provide a combination of variable speed, digital scroll, and/or fixed speed staged compressors. Capacity of variable capacity compressor(s) shall be equal to or greater than the capacity of the largest fixed speed staged compressor.

1. Integral vibration isolators.
2. Internal overcurrent and overtemperature protection.
3. Internal pressure relief.
4. Acoustic blanket.
5. Crankcase heater(s).

M. Refrigeration System:

1. Compressor(s).
2. Condenser coils and fans.
3. Direct expansion cooling coil and supply-air fan.
4. Check valves.
5. Expansion valves with replaceable thermostatic elements.
6. Refrigerant dryers.
7. High-pressure switches.
8. Low-pressure switches.
9. Thermostats for coil freeze-up protection during low-ambient temperature operation or loss of air.
10. Independent refrigerant circuits.
11. Brass service valves installed in discharge and liquid lines.
12. Refrigerant: As scheduled.
13. Compressor Motor Overload Protection: Manual reset.
14. Anti-recycling Timing Device: Prevents compressor restart for five minutes after shutdown.
15. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.

N. Filters: Size, type, and rating as scheduled on the Drawings, in filter racks or galvanized-steel frames as required by filter type.

1. Air Filter and Filter-Holding System Manufacturers:
    a. AAF | Flanders.
    b. AAF International.
    c. Camfil.

O. Heat Exchanger: Stainless-steel construction, including secondary tubes, for natural-gas-fired burners with the following controls:

1. Redundant dual gas valve with manual shutoff.
2. Modulating control with turn-down ratio as scheduled on the Drawings.
3. Direct-spark pilot ignition.

4. Electronic flame sensor.
5. Induced-draft blower.
6. Flame rollout switch.

P. Outside-Air Damper: Linked damper blades with fully modulating, spring-return damper motor and hood.

Q. Economizer: Return- and outside-air dampers with neoprene seals, bird screen, and hood.

1. Damper Motor: Fully modulating spring return with adjustable minimum position.
2. Control: Electronic-control system uses return-air and outside-air temperature to adjust mixing dampers.
3. Relief/Exhaust Damper: For units with relief/exhaust fans, provide gravity-style actuated with bird screen and hood. For units with return fans, provide motorized-style with bird screen and hood.
4. Leakage: Maximum leakage 2.5 percent at nominal airflow of 400 cfm per ton with 1-inch wg pressure differential.

R. Energy Recovery Device: Complying with ASHRAE 90.1 and AHRI 1060.

1. Fixed plate energy recovery core, with economizer bypass damper. Include filters for outdoor air before core. Unit shall modulate bypass damper during frost conditions, bypassing the outside air around the device while allowing exhaust air to flow through device continuously.

S. Electrical:

1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection.
2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
3. Wiring shall be numbered and color-coded to match wiring diagram.
4. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch.
5. Minimum SCCR according to UL 508 shall be as indicated on the Drawings.
6. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
    a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
    b. NEMA KS 1, heavy-duty, nonfusible switch.
    c. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
7. Each motor shall have overcurrent protection.
8. Factory installed power monitor shall detect phase loss and phase reversal to shut down the unit when a fault is detected.

T. Unit Controls: Solid-state control board and components contain at least the following features:

1. Supply-air fan control relay.
2. Default control to ensure proper operation after power interruption.
3. Service relay output.

4. Unit diagnostics and diagnostic code storage.
5. Field-adjustable control parameters.
6. For units indicated to have single zone variable air volume control, utilize hot gas reheat for dehumidification control with space humidity sensor furnished by unit manufacturer for field installation.
7. For units other than single zone control, utilize hot gas reheat for dehumidification control with return air humidity sensor furnished by unit manufacturer for field installation.
8. Provide outside airflow measuring device for minimum airflow setpoint control.
9. Economizer control complying with ASHRAE 90.1 including automated fault detection and diagnostics.
10. Indoor-air quality control with carbon dioxide sensor furnished by unit manufacturer for field installation.
11. Unoccupied mode (outside air damper lockout).
12. Low-refrigerant pressure control.
13. Variable-Air-Volume Control: As scheduled on the Drawings.
    a. For units indicated to have single zone variable air volume (SZVAV) control, provide space temperature sensor furnished by unit manufacturer for field installation.
    b. For units indicated to have discharge air temperature, duct static pressure variable air volume (DAT-DSP VAV) control, variable frequency controller maintains remote supply air duct static pressure. Provide remote duct static pressure sensor for field installation. Factory installed and wired supply air static pressure limit shuts unit down on high pressure.
        1) Provide factory installed differential pressure transmitter.
        2) Provide duct static pressure sensor (Dwyer model A302 or equal) furnished by unit manufacturer for field installation.
    c. Where drawings indicate return fan application, provide differential supply-return airflow tracking.
    d. Where drawings indicate relief fan application, modulate relief fan speed to maintain space pressure.
        1) Provide factory installed differential pressure transmitter, for field connection to space and outdoor static pressure sensors.
        2) Provide space static pressure sensor (Dwyer model A-417A or equal) furnished by unit manufacturer for field installation.
        3) Provide outdoor static pressure sensor (Dwyer model A-306 or equal) furnished by unit manufacturer for field installation.

U. Programmable DDC (with field mounted sensors): Wall-mounted, with integral thermostat function, heating setback and cooling setup with seven-day programming; and the following:
1. Touch sensitive keypad.
2. Digital display of outside temperature, supply-air temperature, return-air temperature, economizer damper position, and control parameters.
3. Deg F space temperature readout.
4. LED indicators.
5. Time and operational mode readout.

6. Status indicator.
7. Battery backup.
8. Dirty-filter indication.

V. BAS Communication Link (BACnet MSTP or IP as indicated on drawings): Providing link between unit controls and BAS. Interface shall communicate data and faults as indicated on drawings.

W. Accessories:

1. Cold-Weather Kit: Electric heater maintains temperature in gas burner compartment.
2. Service Outlets: 115-V, ground-fault, circuit-interrupter type, factory wired such that outlet shall remain energized even if the unit main disconnect is open.
3. Vapor-proof, marine-type, 100-watt service lights in fan sections factory wired such that lighting circuit remains energized even if the unit main disconnect is open, and wired to single on/off toggle switch which brings on all lights at once.
4. Dirty-filter switch.
5. Hail guards of minimum 20 gage galvanized steel, painted to match casing.
6. Vertical vent extension.

X. Isolation Curb: Refer to Division 20 Section “Mechanical Vibration Controls.”

PART 3 EXECUTION

3.01 INSTALLATION

A. Hoist, transport, and rig air conditioning units or their shipping sections into position following procedures recommended by the manufacturer.

B. Install units level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B.

C. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions. Refer to Division 20 Section “Basic Mechanical Materials and Methods” for base requirements. Coordinate wall penetrations and flashing with wall construction.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections.

B. Install piping adjacent to machine to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Division 23 Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination in roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to rooftop unit with flexible duct connectors specified in Division 23 Section "Duct Accessories."
4. Terminate return-air duct through roof structure and insulate space between roof and bottom of unit with 2-inch-thick, acoustic duct liner.

D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. 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.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

1. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Repair malfunctioning units and retest as specified above; or remove malfunctioning units, replace with new units and retest as specified.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean outside coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Adjust vibration isolators.
13. Inspect operation of barometric dampers.
14. Lubricate bearings on fan.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system in summer only.
    b. Complete startup sheets and attach copy with Contractor's startup report.
17. Inspect and record performance of interlocks and protective devices; verify sequences.

18. Operate unit for an initial period as recommended or required by manufacturer.
19. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.
    a. Measure gas pressure on manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure flue-gas temperature at furnace discharge.
    d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
20. Check control interface wiring.
21. Adjust and inspect high-temperature limits.
22. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outside-air, dry-bulb temperature.
    d. Outside-air-coil, discharge-air, dry-bulb temperature.
24. Inspect and verify operation of controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outside-air intake volume.
26. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through outside coil or from outside coil to outside-air intake.
27. Record all final adjustments and control settings.
28. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

3.05 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.06 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners. Refer to Division 20 Section "Mechanical General Requirements."

END OF SECTION

SECTION 23 8126 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

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3.04 DEMONSTRATION 5

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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.02 SUMMARY

A. This Section includes ductless split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.

B. Products supplied but not installed under this Section:

1. Roof curbs and equipment rails.

1.03 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For split-system air-conditioning units to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

D. Seasonal Energy-Efficiency Ratio (SEER): Minimum 13.

1.05 **COORDINATION**

A. Coordinate size and location of concrete or plastic pads for units.

B. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section “Roof Accessories.” Pipe Roof Penetration Enclosures are specified in Division 20 Section “Basic Mechanical Materials and Methods.”

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. Filters: One set of filters for each unit.

2. Infrared remotes where applicable.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Single-Zone Split-System Air-Conditioning Units:

a. Airedale North America, Inc.

b. Carrier Corp.; United Technologies Corporation.

c. Daikin Applied; a member of Daikin Industries, Ltd.; Daikin AC.

d. Johnson Controls-Hitachi.

e. LG Electronics, HVAC Division.

f. Mitsubishi Electric & Electronics America, Inc.; HVAC Advanced Products Division.

g. Panasonic Corporation of North America.

h. Samsung Electronics.

2. Roof Curbs and Equipment Rails:

a. Pate Company (The).

b. Roof Products and Systems Corp.

c. ThyCurb; a division of THYBAR Corporation.

2.02 **SINGLE-ZONE DUCTLESS SPLIT SYSTEM AIR CONDITIONER**

A. Complete packaged air conditioning unit factory fabricated and tested.

B. Indoor Evaporator Section: Complete with fan section, motor, washable filter, condensate drain pan, field installed condensate pump, and direct expansion evaporator section. Include factory-installed float switch to detect high condensate water level and disable fan operation.

C. Air Cooled Condensing Section: Completely factory piped for single point connection of refrigerant lines. Condensing unit with propeller fan shall be matched to evaporator section to provide cooling capacity as scheduled on drawings.

D. Controls: Unit furnished with factory installed microprocessor controls. Provide wireless remote or unit mounted control or wall thermostat, which shall provide selection of all functions and control of room temperature set points. Furnish and install one mounting bracket for each wireless remote control.

E. Units Serving Areas that Contain Additional Heating and Cooling Equipment: Provide with electro-mechanical controls to allow a common DDC space sensor to control the unit.

F. Provide complete refrigerant piping circuit (including all piping specialties) sized in accordance with manufacturer's requirements to interconnect evaporator and condenser sections.

G. Wall-Mounting, Evaporator-Fan Components:

1. Cabinet: With removable panels for servicing, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.

3. Fan: Direct drive, centrifugal fan.

4. Fan Motors: Comply with requirements in Division 20 Section "Motors."

a. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

5. Filters: Permanent, cleanable.

H. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Reciprocating or Scroll.

b. Include refrigerant charge.

c. Refrigerant: R-410A.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.

4. Fan: Aluminum-propeller type, directly connected to motor.

5. Motor: Permanently lubricated, with integral thermal-overload protection.

6. Low Ambient Kit: Permits operation down to 0 deg F.

I. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.

2. Fan-speed selection, including auto setting.

J. Automatic-reset timer to prevent rapid/short cycling of compressor.

K. Minimum SCCR: 22,000A.

2.03 **ACCESSORIES**

A. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, and sealed; factory-insulated suction line with flared fittings at both ends.

B. Roof Curbs and Equipment Rails:

1. Minimum 18 gage welded galvanized steel construction.
2. Integral base flange or plate.
3. Factory installed insect and decay resistant wood nailer.
4. Top of curb or equipment support shall be level and extend a minimum of 8 inches above the top of the roof insulation.

C. Automatic Condensate Pump Units (Field Installed)

1. Manufacturers:
   a. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
   b. Beckett Corporation.
   c. Hartell Pumps Div.; Milton Roy Co.
   d. Hydromatic Pump Company; Division of Pentair Pump Group.
2. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls.

D. Automatic Condensate Pump Units (Field Installed Above Ceiling Applications)

1. Manufacturers:
   a. Hartell Pumps Div.; Milton Roy Co.; Model A2-X-1965.
2. Description: Packaged units with corrosion-resistant pump, dual-voltage thermally protected motor, cast aluminum tank with cover, and automatic controls. Include auxiliary safety switch; junction box wire connections, with 3/4-inch knock out for conduit; and factory- or field-installed check valve.

E. Wall Sleeve-Seal Systems:

1. Manufacturers:
   a. Airex Manufacturing, Inc.; Pro-System Kit.
2. Description: Exterior wall seal system for HVAC refrigerant line set piping penetrations through the building envelope.

PART 3 EXECUTION

3.01 **INSTALLATION**

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install grade-mounting, compressor-condenser components on 2-inch thick reinforced precast concrete, or plastic pad; extending 2 inches beyond unit perimeter.

D. Deliver roof curbs and equipment support to site for installation under Division 07. Install roof-mounting compressor-condenser components on equipment supports specified. Anchor units to supports with removable, cadmium-plated fasteners. Install wind baffle according to manufacturer’s installation instructions.

E. Install and connect refrigerant tubing to components. Install tubing to allow access to unit. Evacuate and charge with refrigerant in accordance with manufacturers instructions.

3.02 **CONNECTIONS**

A. Install piping adjacent to unit to allow service and maintenance.

B. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.03 **FIELD QUALITY CONTROL**

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.04 **DEMONSTRATION**

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

END OF SECTION

SECTION 23 8241 - PROPELLER FAN UNIT HEATERS – STEAM, HOT WATER, ELECTRIC

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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.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.02 SUMMARY

A. This Section includes propeller fan unit heaters with hot-water coils.

1.03 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each unit type and configuration.

B. Shop Drawings: Submit the following for each unit type and configuration:

1. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.

C. Coordination Drawings: Plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which unit heaters will be attached.

3. Other items, including the following:
    a. Lighting fixtures.
    b. Sprinklers.
    c. Ductwork.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

1.04 **QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Electric Unit Heaters:
    a. Brasch Manufacturing Co.
    b. Chromalox, Inc.; a division of Emerson Electric Company.
    c. Electra Tek Corp.
    d. Indeeco.
    e. Markel Products; a division of TPI Corporation.
    f. Sterling Radiator; a Mestek Company.
    g. Trane.

2.02 **UNIT HEATERS**

A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

2.03 **CASING**

A. Cabinet: Removable panels for maintenance access to controls.

B. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

C. Discharge Louver: Four-way adjustable louvers for horizontal units and adjustable pattern diffuser for projection units.

2.04 **ELECTRIC-RESISTANCE HEATING ELEMENTS**

A. Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16

inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.

2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.05 **FAN**

A. Propeller type, aluminum wheel directly mounted on motor shaft in the fan venturi.

2.06 **FAN MOTORS**

A. Comply with requirements in Division 20 Section "Motors."

B. Motor Type: Permanently lubricated.

2.07 **CAPACITIES AND CHARACTERISTICS**

A. Refer to Schedule on Drawings.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before propeller unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION**

A. Install propeller unit heaters level and plumb.

B. Install propeller unit heaters to comply with NFPA 90A.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Division 20 Section "Hangers and Supports." Vibration hangers are specified in Division 20 Section "Mechanical Vibration Controls."

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.03 **CONNECTIONS**

A. Comply with safety requirements in UL 1995.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.04 **FIELD QUALITY CONTROL**

A. Testing: Perform the following field quality-control testing and report results in writing:

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safeties.

B. Remove and replace malfunctioning units and retest as specified above.

3.05 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller fan unit heaters. Refer to Division 20 Section "Mechanical General Requirements."

END OF SECTION

SECTION 23 8244 - CENTRIFUGAL FAN CABINET UNIT HEATERS (ELECTRIC)

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3.05 DEMONSTRATION 4

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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.02 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Location and arrangement of integral controls.
4. Wiring Diagrams: Power, signal, and control wiring.

B. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.

5. Items penetrating finished ceiling, including the following:
    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
6. Perimeter moldings for exposed or partially exposed cabinets.

1.04 **CLOSEOUT SUBMITTALS**

A. Field quality-control test reports.

B. Operation and Maintenance Data: For cabinet unit heaters to include in operation and maintenance manuals.

1.05 **QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

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. Cabinet Unit Heater Filters: Furnish spare filter for each filter installed.

PART 2 PRODUCTS

2.01 **MANUFACTURED UNITS**

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

1. Berko Electric Heating; a division of Marley Engineered Products.
2. Brasch Manufacturing Company, Inc.
3. Chromalox Advanced Thermal Technologies; Spirax-Sarco Engineering plc.
4. Indeeco Heating Solutions; ASPEQ Heating Group.
5. Markel Products; a division of TPI Corporation.
6. QMark Electric Heating; a division of Marley Engineered Products.

B. Description: A factory-assembled and -tested unit complying with AHRI 440.

1. Comply with UL 2021.

C. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall have erosion-resistant coating to prevent erosion of glass fibers.

1. Thickness: Minimum 1/2 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.

2. Recessing Flanges for Units That Are Semirecessed or Fully Recessed: Steel, finished to match cabinet.

3. Control Access Door: Key operated.

4. Base for Surface, Vertical, Wall-Mounting Units: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber Treated with Adhesive: Throw-away type 80 percent arrestance and 5 MERV.

F. Electric-Resistance Heating Coil: Non-glowing type. Steel fins brazed to high temperature resistance wire enclosed in incoloy sheath; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

G. Fan and Motor Board: Removable.

1. Fan: Forward curved, double-width centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.

2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 20 Section "Motors."

3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

H. Electrical Connection: Factory wire motors and controls for a single field connection.

I. Capacities and Characteristics: Refer to Schedule on Drawings.

2.02 **UNIT CONTROLS**

A. Control devices are specified in Division 23 Section "Temperature Controls," and operational sequences are indicated on the Drawings.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before cabinet unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION**

A. Install cabinet unit heaters to comply with NFPA 90A.

B. Suspend cabinet unit heaters from structure with elastomeric hangers.

1. Vibration isolators are specified in Division 20 Section "Mechanical Vibration Controls."

C. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.03 **CONNECTIONS**

A. Comply with safety requirements in UL 1995.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.04 **FIELD QUALITY CONTROL**

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.05 **DEMONSTRATION**

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

END OF SECTION

SECTION 26 0010 - ELECTRICAL GENERAL REQUIREMENTS

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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 work of this section.

1.02 SUMMARY

A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.03 REFERENCES

A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. ANSI - American National Standards Institute; www.ansi.org.

2. ASTM - ASTM International; www.astm.org.
3. CSI - Construction Specifications Institute (The); www.csiresources.org.
4. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
5. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
6. NEC - National Electrical Code
7. NECA - National Electrical Contractors Association; www.necanet.org.
   a. NECA 1-2000, “Practices for Good Workmanship in Electrical Contracting (ANSI).”
8. NEMA - National Electrical Manufacturers Association; www.nema.org.
9. NETA - InterNational Electrical Testing Association; www.netaworld.org.
10. UL - Underwriters Laboratories Inc.; www.ul.com.

1.04 **QUALITY ASSURANCE**

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test, and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.
   1. Contract Documents are complementary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
   2. The Contractor understands that the work herein described shall be complete in every detail.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State, and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.
   1. Notify the Architect/Engineer if revisions to the Drawings or Specifications are required to conform to applicable ordinances, codes, or regulations. Identify the cost associated with these revisions in the bid.

C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county, and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Avoid interference with the work of other trades. Remove and relocate any work which in the opinion of the Owner’s Representatives causes interference.

1.05 **CODES, PERMITS AND FEES**

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals, and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules, and regulations.

B. Comply with rules of local utility companies. Coordinate with the utility company supplying service to the installation and determine all devices including, but not limited to, all current and potential transformers, meter boxes, C.T. cabinets, and meters which will be required and include the cost of all such items and all utilities costs in proposal.

C. All work shall be executed in accordance with the rules and regulations outlined in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing

authorities. Where the Drawings and/or Specifications indicate materials or construction that exceed code requirements, the Drawings and/or Specifications shall govern.

1.06 **DRAWINGS**

A. The Drawings show the location and general arrangement of equipment, electrical systems, and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes, and accessories as may be required to meet such conditions.

C. Deviations from the Drawings, apart from minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades, and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.07 **MATERIAL AND EQUIPMENT MANUFACTURERS**

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new, be standard products of manufacturers regularly engaged in the production of electrical equipment and be of the manufacturer's latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

C. Where existing equipment is modified to include new switches, circuit breakers, metering, or other components, the new components shall be by the original equipment manufacturer and shall be listed for installation in the existing equipment. Where original equipment manufacturer components are not available, third-party aftermarket components shall be listed for the application and submitted to the engineer for approval. Reconditioned or salvaged components shall not be used unless specifically indicated on the drawings.

1.08 **INSPECTION OF SITE**

A. Visit the site, examine, and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.09 **ITEMS REQUIRING PRIOR APPROVAL**

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1

specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information, and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

A. Submit project-specific submittals for review in compliance with Division 1.

B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.

C. If deviations (not substitutions) from the Contract Documents are deemed necessary by the Contractor, the details of such deviations, the reason for the deviation, and the resulting changes shall be included with the submittal for approval.

D. Submit for approval shop drawings for electrical systems or equipment indicated in other sections of electrical specs. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures).

1.11 COORDINATION DRAWINGS

A. Submit project specific coordination drawings for review in compliance with Division 1 Specification Sections.

1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Manual shall be provided on electronic media. All literature shall be combined in one document and shall be properly bookmarked with all applicable sections. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all electrical systems including, but not limited to:

1. Routine maintenance procedures.
2. Trouble-shooting procedures.
3. Contractor's telephone numbers for warranty repair service.
4. Submittals.
5. Recommended spare parts list.
6. Names and telephone numbers of major material suppliers and subcontractors.

7. System schematic drawings on 8-1/2" x 11" sheets.

1.13 **RECORD DRAWINGS**

A. Submit record drawings in compliance with Division 01.

B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media which have been neatly marked to represent as-built conditions for all new electrical work. Modifications to original drawings shall be marked with a contrasting color so the marks are readily apparent.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer, and Owner at their request during construction.

1.14 **INSTRUCTION OF OWNER PERSONNEL**

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.

D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.15 **WARRANTY**

A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship, or failure to follow the contract documents.

B. Contractor shall be responsible for any temporary services including equipment and installation required to maintain operation as a result of any equipment failure or defect during warranty period.

C. File with the Owner all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.16 **USE OF EQUIPMENT**

A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

1.17 **COORDINATION**

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.

3. To allow right of way for piping and conduit installed at required slope.

4. To ensure that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions; and to maintain 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. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 **COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION**

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange, and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.02 **INSTALLATION OF EQUIPMENT**

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.

B. Device Location:

1. Allow for wiring devices, control devices, and fire alarm devices to be relocated within a 10’ radius to accommodate final coordination with furnishings and other finish elements. Devices relocated prior to installation shall be done without additional cost to the project.

3.03 **WORK IN EXISTING BUILDINGS**

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.

C. Consult with the Owner’s Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.

D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal, or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.04 **TEMPORARY SERVICES**

A. Provide and remove upon completion of the project, following the general conditions and as described in Division 01, a complete temporary electrical and telephone service during construction.

3.05 **CHASES AND RECESSES**

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.06 **CUTTING, PATCHING AND DAMAGE TO OTHER WORK**

A. Refer to General Conditions for requirements.

B. All cutting, patching, and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.07 **EXCAVATION AND BACKFILLING**

A. Provide all excavation, trenching, tunneling, dewatering, and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.

B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.

C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

D. Backfill all excavations inside building, under drives, and parking areas with well-tamped granular material. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

E. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen excavated material in such a way as to prevent settling.

3.08 **EQUIPMENT CONNECTIONS**

A. Make connections to equipment and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.09 **CLEANING**

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.10 **PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS**

A. Equipment and materials shall be protected from theft, injury, or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.11 **EXTRA WORK**

A. For additional electrical work which may be proposed or requested, furnish an itemized cost breakdown of material and labor required to complete the work. Proceed only after receiving a written authorization.

B. Before providing an itemized break-down for additional electrical work, submit unit prices for the following items: 1/2", 3/4", 1", 1-1/2" EMT conduit; #12, #10, #8, #6, #2 building wire; duplex receptacles, GFCI receptacles, data box and raceway, V4000 wiremold, and fittings fire alarm audible/visual notification appliance and visual notification appliance, clocks and speakers, and other common electrical work which may be anticipated for any future revisions. These unit costs, once agreed to, shall be applied to additions and deducts for all project change orders.

3.12 **DRAWINGS AND MEASUREMENTS**

A. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor’s responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

3.13 **PROJECT COMMISSIONING**

A. Refer to Division 01 “Project Commissioning” and the Commissioning Manual.

B. Purpose: Training, documentation and verification of the operation and functional performance of electrical systems for compliance with the “design intent.”

END OF SECTION

SECTION 26 0513 - MEDIUM-VOLTAGE CABLES

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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. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.03 DEFINITIONS

A. Jacket: A continuous nonmetallic outer covering for conductors or cables.

B. NETA ATS: Acceptance Testing Specification.

C. Sheath: A continuous metallic covering for conductors or cables.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.05 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

1.07 **FIELD CONDITIONS**

A. 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 Owner's representative no fewer than seven days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without written permission from Owner's representative.

PART 2 PRODUCTS

2.01 **MANUFACTURERS:**

A. Subject to compliance with requirements, provide products by the following:

B. Product by one of the following:

1. Cables:

a. Aetna Insulated Wire, Inc.; a Berkshire Hathaway company.

b. General Cable Technologies Corporation.

c. Kerite; a Marmon Wire & Cable/Berkshire Hathaway company.

d. Okonite Company (The).

e. Prysmian Cables & Systems.

f. Southwire Company.

g. Superior Essex.

2. Cable Splicing and Terminating Products and Accessories:

a. RTE Components; Cooper Power Systems, Inc.

b. Thomas & Betts Corporation.

c. 3M; Electrical Markets Division.

d. Tyco Electronics; Raychem Products.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.02 **SYSTEM DESCRIPTION**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

2.03 **CABLES**

A. Cable Type: UL Type MV 90.

B. Comply with UL 1072, AEIC CS8 , ANSI/ICEA S-93-639/NEMA WC 74, and ICEA S-94-649.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B

E. Conductor Insulation: Ethylene-propylene rubber (EPR).

1. Voltage Rating: 15 kV.

2. Insulation Thickness: 133 percent insulation level.

F. Shielding with Concentric Neutral: Solid copper wires helically applied over semiconducting insulation shield sized for 1/3 neutral capacity. Provide insulating encapsulating cable jacket over the neutral wires.

G. Cable Jacket: Linear Low Density Polyethylene (LLDPE).

2.04 CONNECTORS

A. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

B. Copper-Conductor Connectors: Aluminum barrel crimped connectors.

2.05 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations, Interior: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.

2. Class 1 Terminations, Exterior: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

2.06 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A-load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.

2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.

3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.

4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

2.07 **SPLICE KITS**

A. Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink-rubber, in-line splicing kit.
4. Premolded, EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.
5. Separable multiway splice system with all components for the required splice configuration.

2.08 **MEDIUM-VOLTAGE TAPES**

A. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.

B. Silicone rubber-based, 12-mil self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches wide.

C. Insulating-putty, 125-mil elastic filler tape. Minimum 1-1/2 inches wide.

2.09 **ARC-PROOFING MATERIALS**

A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

2.10 **SOURCE QUALITY CONTROL**

A. Test and inspect cables according to ICEA S-94-649 before shipping.

PART 3 EXECUTION

3.01 **INSTALLATION**

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 26 0529 "Hangers and Supports for Electrical Systems."

F. Install "buried-cable" warning tape 12 inches above cables.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

H. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

I. Install cable splices at pull points and elsewhere as indicated; use standard kits.

J. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

K. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

L. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with two layers of 1-inch- wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

M. Seal around cables passing through fire-rated elements according to Section 07 8413 "Penetration Firestopping."

N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

O. Identify cables according to Section 26 0553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.02 **FIELD QUALITY CONTROL**

A. Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.

4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 26 0519 - CONDUCTORS AND CABLES

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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. Section includes:

1. Building wires and cables rated 600V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

1. Division 26 Section “Control-Voltage Electrical Power Cables” for multi-conductor cables for electrical control and communications systems operating at 70V and less.

1.03 ACTION SUBMITTALS

A. Submit letter of compliance (intent) for copper and aluminum building wire.

B. Provide product data for the following:

1. Metal-Clad Cable, Type MC
2. Mineral Insulated Cable, Type MI
3. 2- Hour Fire Rated Mc Power Cable
4. Power Cable for Variable Frequency Controlled Motors

1.04 **INFORMATIONAL SUBMITTALS**

A. Field Quality-Control Test Reports.

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. Comply with NFPA 70.

PART 2 PRODUCTS

2.01 **COPPER BUILDING WIRE**

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

D. Conductor Insulation:

1. Type THHN/THWN-2: Comply with UL 83.

2. Type THW/THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.

3. Type XHHW-2: Comply with UL 44.

2.02 **ALUMINUM BUILDING WIRE**

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

1. Allowed only for conductors used in feeders 100A and larger.

B. Manufacturers:

1. General Cable

2. Southwire

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Aluminum, complying with ASTM B 800 and ASTM B 801.

E. Conductor Insulation:

1. Type XHHW-2: Comply with UL 44.

2.03 **METAL-CLAD CABLE, TYPE MC**

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers:

1. AFC Cable Systems
2. Alpha Wire Company
3. American Bare Conductor
4. Belden
5. Encore
6. General Cable
7. Okonite
8. Service Wire Co.
9. Southwire Company

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multi-circuit with color-coded conductors for branch circuit distribution.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors:

1. Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
2. Aluminum, complying with ASTM B 800 and ASTM B 801 for conductors #1 AWG and larger.

F. Ground Conductor: Insulated. Ground conductor sized as indicated on drawings (reduced ground conductor is not acceptable).

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

H. Armor: Aluminum, interlocked.

I. Jacket: PVC applied over armor.

2.04 2-HOUR FIRE RATED MINERAL INSULATED CABLE, TYPE MI

A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V.

B. Manufacturers:

1. KME America
2. Pentair
3. Watlow Electric Manufacturing

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. UL 2196 for fire resistance.

3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multi-circuit with color-coded conductors.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper.

F. Insulation: Compressed magnesium oxide.

G. Sheath: Copper.

2.05 **2-HOUR FIRE RATED RHW-2, 600 VOLT**

A. Description: RHW-2 cable listed by UL as a 2-hour fire rated when installed in accordance with installation procedures complying with the product listing.

B. Manufacturers:

1. Prysmian Group/Draka – Lifeline.

C. Standards:

1. Listed and labeled as defined in NFPA 70 Article 728.4, by UL, and marked for intended location and use.

2. UL 44 listed for NEC compliance.

3. UL 2196 listed for fire resistance.

4. Electrical Circuit Integrity Systems (FHIT) – System No. 25B or System No. 25C, of the UL Fire Resistance Directory.

5. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide", and NFPA 70, Article 728.120.

D. Conductors: Annealed Copper, Class B strand complying with ASTM B-3 and B-8.

E. Insulation: Thermoset, low smoke zero halogen ceramifiable silicone rubber.

F. Jacket: Low smoke, zero halogen, cross-linked polyolefin.

2.06 **2-HOUR FIRE RATED MC POWER CABLE**

A. Description: MC Power cable listed by UL as a 2 hour Fire Rated when installed in accordance with installation procedures complying with the product listing.

B. Manufacturers:

1. OMNI Cable – Vita Link

2. Prysmian GroupDraka – Lifeline MC.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. UL 1569

3. UL 2196 for fire resistance.

4. Electrical Circuit Integrity Systems (FHIT) – System No. 120 or System No. 50, of the UL Fire Resistance Directory

5. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide," and NFPA 70, Article 728.120 and Article 310.120.

D. Conductors: Annealed Copper, Class B strand complying with ASTM B-3 and B-8.

E. Insulation: Thermoset, low smoke zero halogen silicone rubber.

F. Armor: Continuously welded and corrugated copper exceeding the NEC requirement for equipment grounding conductor.

G. Outer Jacket (if required): Black low smoke zero halogen polyolefin.

2.07 **POWER CABLE FOR VARIABLE FREQUENCY CONTROLLED MOTORS**

A. Description: A factory assembly of three conductor cable with three symmetrical ground conductors, a continuous shield, an overall PVC jacket and a product specific connector and termination kit.

B. Manufacturers:

1. Service Wire Co.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. Comply with UL 1277

3. Comply with ICEA S-95-658/NEMA WC 70 for Type TC-ER Power Cable (for VFD application)

4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit feeder.

E. Phase Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Bare copper.

G. Phase Conductor Insulation: Moisture resistant, flame retardant, cross linked polyethylene (2KV RHW-2) suitable for 90degC conductor temperature operation inf dry, damp and wet locations

H. Shield: Helically applied minimum 5 mils thick bare copper with minimum 50% overlap.

I. Armor: Steel or Aluminum, interlocked.

J. Jacket: Oil resistant PVC

K. Connector: Water-tight and UL listed for installation on supplied TC cable (tray cable) assembly.

1. Body material: nickel clad aluminum

2. Connector shall provide a 360-degree electrical bonding of the copper tape shield to the connector body.

3. Connection of the copper tape shield to the connector body shall be accomplished by an integral and self-retaining grounding collar that automatically provides a 360-degree connection as the connector is tightened.

4. The connector assembly shall be designed to ensure against loosening of threads due to vibration.

5. A UL listed chrome plated grounding and bonding locknut with a 360-degree knurled teeth connection shall be provided with each connector to secure and bond the connector to the inverter cabinet / motor termination box.

6. Tinned copper braids (minimum ¾ inches wide) with installation hardware to connect the copper tape shield to the inverter enclosure / back-panel and to the motor frame shall be provided as part of the cable system.

L. Termination Kit: Tinned copper braids (minimum ¾ inches wide) with installation hardware to connect the copper tape shield to cable core, to the inverter enclosure/back-panel, and to the motor frame shall be provided as part of the cable system.

1. Braid width shall be determined by cable core diameter size and shall be placed at a separation of 180 degrees.

2.08 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Refer to application schedule on the drawings

B. If providing aluminum feeders, contractor is responsible for providing correct feeder, equipment ground and conduit size based on voltage drop and any de-rating required.

C. Feeders and Branch Circuits: Solid or stranded for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

D. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).

E. Use conductor not smaller than 14 AWG for 120V control circuits.

F. Where equipment is listed for use with copper conductors only, use copper conductors for the entire length of feeder.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Refer to application schedule on the drawings

B. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel wire-mesh strain relief device at terminations to suit application.

C. Connection between Variable Frequency Controllers and Motors: Use power cable for variable frequency- controlled motors. Install and terminate according to cable manufacturer’s recommendations.

D. Isolated Power System Circuits: Use Type XLP in raceway.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 0533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

G. Neatly train and lace wiring inside boxes, equipment, and panelboards.

H. Provide a separate neutral conductor for each circuit unless multi-wire branch circuits are specifically indicated on the drawings.

I. Electrical Contractor shall be responsible for de-rating of conductors as required by N.E.C. when more than three current carrying conductors are installed in a single raceway or cable. Neutral conductors shall be considered current carrying conductors.

J. Type MC cable shall be supported and secured at intervals not exceeding 4'-0" in new construction.

K. AC/MC cable shall not be used for home runs to receptacle or distribution panels.

L. Where AC/MC cable is permitted by the specifications, AC/MC cable shall not be bundled.

M. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.

N. Do not route conductors across roof without prior approval from engineer.

O. Install and terminate power cable for variable frequency- controlled motors according to cable manufacturer’s recommendations.

P. Install fire resistive cable assemblies (Type MI cable and/or fire rated MC cable) in accordance with the manufacturer’s instructions and the product UL listing.

1. Do not paint fire resistive cable assemblies.

3.04 **CONNECTIONS**

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

2. Use compression type terminations for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Clean conductor surfaces before installing lugs and connectors.

E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

F. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

G. Use piercing connector with insulating covers for conductor splices and taps, 8 AWG and larger only for taps to existing feeders. Do not use piercing connectors in new construction.

H. Use Sta-Kon connectors to terminate stranded conductors #10 AWG and smaller to screw terminals.

I. Use insulated spring wire connectors with plastic caps (wire nuts) for copper conductor splices and taps, 10 AWG and smaller. Push-in style connectors are not permitted.

J. Provide lugs suitable for bussing and conductor material used.

K. Use appropriately sized compression pin adapters to make terminations at equipment where equipment lugs cannot accommodate conductors that are oversized for voltage drop or similar conditions.

3.05 **IDENTIFICATION**

A. Identify and color-code conductors and cables according to Section 26 0553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 **SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 0533 "Raceways and Boxes."

3.07 **FIRESTOPPING**

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping".

3.08 **FIELD QUALITY CONTROL**

A. Perform the following field quality control tests in accordance with Division 26 Section "Electrical Testing".

1. Description: Test all feeders rated 100 A and above.
2. Visual and Mechanical Inspection
    a. Inspect cables for physical damage and proper connection in accordance with the one line diagram.
    b. Test cable mechanical connections with an infrared survey.
    c. Check cable color-coding against project Specifications and N.E.C. requirements.
3. Electrical Tests
    a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for 1 minute.
    b. Perform continuity test to insure proper cable connection.
4. Test Values
    a. Minimum insulation resistance values shall be not less than fifty mega-ohms.

B. 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

SECTION 26 0523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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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. Section Includes control-voltage electrical power cables for the following systems:

1. Temperature controls
2. Building automation
3. Lighting control
4. Low voltage lighting power limited circuits
5. Shade control systems
6. Class 1 and Class 2 power limited circuits supplying LED lighting on the secondary of low voltage drivers or power supplies.
7. Any control voltage, signal cable or power limited circuit required.

B. Section Includes the following:

1. Category 5e balanced twisted pair cable.

2. Category 6 balanced twisted pair cable.
3. Category 6a balanced twisted pair cable.
4. Balanced twisted pair cable hardware.
5. Twin-axial data highway cable.
6. RS-232 cable.
7. RS-485 cable.
8. Control cable.
9. Control-circuit conductors.

C. Related Requirements:

1. Section 26 0010 "Electrical General Requirements".
2. Section 26 0529 “Hangers and Supports for Electrical Systems”.
3. Section 26 0533 “Raceways and Boxes”.
4. Section 28 3100 “Fire Alarm” for cable specific to fire alarm systems signaling line circuits and notification appliance circuits.

1.03 **ACTION SUBMITTALS**

A. Product Data:

1. Category 5e balanced twisted pair cable.
2. Category 6 balanced twisted pair cable.
3. Category 6a balanced twisted pair cable.
4. Balanced twisted pair cable hardware.
5. Twin-axial data highway cable.
6. RS-232 cable.
7. RS-485 cable.
8. Control cable.
9. Control-circuit conductors.

1.04 **INFORMATIONAL SUBMITTALS**

A. Source quality-control reports.

B. Field quality-control reports.

PART 2 PRODUCTS

2.01 **PERFORMANCE REQUIREMENTS**

A. Cable specifications shall meet the minimum requirements of the equipment or control system manufacturer for which the cables are intended to support, or as specified in other sections.

1. Coordinate with submittals for each special system, where applicable.
2. Where cable specifications for specific systems differ from these specifications, use the cable with performance characteristics required by the manufacturer, with the appropriate environmental rating and color coding as indicated.

3. All execution articles in this section shall apply to all control voltage cable systems in addition to control system manufacturer requirements. Where these specifications differ or conflict with the system manufacturer instructions or recommendations, the more restrictive requirements shall apply.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inch or less.

2. Peak Optical Smoke Density: 0.5 or less.

3. Average Optical Smoke Density: 0.15 or less.

D. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

E. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.02 CATEGORY 5E BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

C. Conductors: 100 ohm, No. 24 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP)

E. Cable Rating: Plenum.

F. Jacket: Color coded thermoplastic.

1. Color shall be determined by system served by cabling.

2.03 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.

B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

C. Conductors: 100 ohm, No. 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP).

E. Cable Rating: Plenum.

F. Jacket: Color coded thermoplastic.

1. Color shall be determined by system served by cabling.

2.04 CATEGORY 6A BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.

B. Standard: Comply with TIA-568-C.2 for Category 6a cables.

C. Conductors: 100 ohm, No. 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP).

E. Cable Rating: Plenum.

F. Jacket: Color coded thermoplastic.

1. Color shall be determined by system served by cabling.

2.05 **BALANCED TWISTED PAIR CABLE HARDWARE**

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of balanced twisted pair cable required for the system.

2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.

3. Cables must be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.

D. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.

b. Labeling areas adjacent to conductors.

c. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19 inch equipment racks.

3. Number of Jacks per Field: One for each four-pair cable indicated plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Cords: Factory-made, four-pair cables in lengths required for specific application; terminated with an eight-position modular plug at each end.

1. Patch cords must have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords must have latch guards to protect against snagging.

F. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.

2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.

3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded balanced twisted pair cable.

2. Designed to snap-in to a patch panel or faceplate.

3. Standards:

a. Category 5e, unshielded balanced twisted pair cable must comply with IEC 60603-7-2.

b. Category 6, unshielded balanced twisted pair cable must comply with IEC 60603-7-4.

c. Category 6a, unshielded balanced twisted pair cable must comply with IEC 60603-7-41.

4. Marked to indicate transmission performance.

H. Faceplate:

1. Four port, minimum, vertical single-gang faceplates designed to mount to single-gang wall boxes.

2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 2726 "Wiring Devices”.

3. Metal Faceplate: Stainless steel, complying with requirements in Section 26 2726 "Wiring Devices”.

4. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

I. Legend:

1. Machine printed, in the field, using adhesive-tape label.

2. Snap-in, clear-label covers and machine-printed paper inserts.

2.06 TWIN-AXIAL DATA HIGHWAY CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 20 AWG, 22AWG or 24 AWG, stranded (7x28), (7x30), (7x32) tinned-copper conductors and number of pairs as required for the application and/or required by the system manufacturer’s recommendations.

2. Plastic insulation.

3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.

4. Plastic jacket.

5. Pairs are cabled on common axis with 24 AWG, stranded (7x32) tinned-copper drain wire.

6. Flame Resistance: Comply with NFPA 262.

2.07 RS-232 CABLE

A. Plenum-Type, TIA 232-F:

1. Three or Nine, No. 22 AWG, stranded (7x30) tinned copper conductors. Conductor quantity as required for application.

2. PE insulation.

3. Aluminum foil-polyester tape shield with 100 percent shield coverage.

4. Fluorinated ethylene propylene jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.08 **RS-485 CABLE**

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.09 **CONTROL CABLE**

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG stranded tinned-copper conductors. Number of pairs and gauge as required by the application.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.10 **CONTROL-CIRCUIT CONDUCTORS**

A. Class 1 Control Circuits:

1. Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
2. Type TC, complying with UL 1277 in raceway.
3. Type MC, complying with UL 1569.

B. Class 2 Control Circuits:

1. Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
2. Power-limited cable, concealed in building finishes.
3. Power-limited tray cable, in cable tray.

C. Class 3 Remote-Control and Signal Circuits:

1. Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
2. Power-limited cable, concealed in building finishes.
3. Power-limited tray cable, in cable tray
4. Type TW or Type TF, complying with UL 83, in raceway.

D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.11 **SOURCE QUALITY CONTROL**

A. Factory test twisted pair cables according to TIA-568-C.2.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Test category 5E, 6 and 6A cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.02 **INSTALLATION OF RACEWAYS AND BOXES**

A. Comply with requirements in Section 26 0533 "Raceways and Boxes" for raceway selection and installation requirements for conduits as supplemented or modified in this Section.

1. Outlet boxes for cables must be no smaller than 4 inch square by 2-1/8 inch deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.

2. Flexible metal conduit must not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.

2. Install cable trays to route cables if conduits cannot be located in these positions.

3. Secure conduits to backboard if entering the room from overhead.

4. Extend conduits 3 inch above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.03 **INSTALLATION OF CONDUCTORS AND CABLES**

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.

2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."

3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, control panels, cross-connect and patch panels.

4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points unless specifically allowed and indicated in the system manufacturers installation instructions.

5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.

6. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire must be copper, and grounding methods must comply with IEEE C2.
16. Where ceilings consist of exposed construction, cable shall be installed on top of joists, beams etc. and shall be concealed from view. Where the structural elements do not allow for the cable to be installed in a concealed fashion, then install the cable in conduit.
17. Install all cable in conduit in mechanical rooms, loading docks and similar service spaces.
18. Drops to surface mounted devices shall be installed in conduit in service spaces or surface raceway in finished spaces.
19. Where the ceiling is exposed, route the conduit or raceway up to the structural member that will conceal the cable.
20. No exposed cable shall be visible below the ceiling.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces and other equipment rooms with terminating hardware and interconnection equipment.
2. Suspend cable that is not in a raceway a minimum of 8 inch above ceilings by cable supports not more than 30 inch apart.
3. Unless specifically permitted otherwise for open ceiling applications in finished areas, cable must not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

E. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only when space under floor is used for the transport of environmental air.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of 72 inch of cable in a coil not less than 12 inch in diameter.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment must be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inch.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inch.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inch.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment must be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inch.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inch.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inch.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures must be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inch.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inch.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inch.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inch.

3.04 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.05 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.06 FIRESTOPPING

A. Comply with requirements in Section 07 8413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.07 **GROUNDING**

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For control-voltage wiring and cabling, comply with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems."

C. Observe installation instructions for grounding according to system manufacturer's installation instructions, where applicable.

3.08 **IDENTIFICATION**

A. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers must use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

D. Color Coding: Provide control voltage cables with jacket color to indicate system served: Coordinate with owner's published standards or owner's network and security consultants.

1. Use the following color-coding scheme, or submit project specific scheme for approval:

a. Temperature controls: Blue with unique striping for each sub-system

b. Building automation backbone: Blue

c. Lighting control: Green

d. Low voltage lighting power limited circuits: Black with grey stripe

e. Shade control systems: Black with red stripe

f. Class 1 and Class 2 power limited circuits supplying LED lighting on the secondary of low voltage drivers or power supplies. Black with green stripe

g. Miscellaneous power limited cables not otherwise specified: Black.

h. Reserved for Fire Alarm: Red

i. Reserved for Enterprise Network/Telecommunications Cable: White

j. Reserved for Video Surveillance: Purple

k. Reserved for Access Control: Orange

3.09 **FIELD QUALITY CONTROL**

A. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 0526 - GROUNDING AND BONDING

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

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. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements”.
2. Division 26 Section “Conductors and Cables”.

1.03 REFERENCES

A. ASTM B 3: Specification for Soft or Annealed Copper Wire.

B. ASTM B 8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.

C. ASTM B 33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

D. ASTM B 187: Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.

E. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

F. IEEE 142: Grounding of Industrial and Commercial Power Systems.

G. IEEE 1100 – 1992: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.

H. IEEE C2: National Electrical Safety Code.

I. NETA MTS – 2001: Maintenance Testing Specifications.

J. NFPA 70: National Electrical Code.

K. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.

L. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.

M. UL 467: Grounding and Bonding Equipment.

N. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

O. UL 486B: Wire Connectors for Use with Aluminum Conductors.

1.04 **ACTION SUBMITTALS**

A. Product Data: For the following:

1. Ground rods.

1.05 **INFORMATIONAL SUBMITTALS**

A. Field Quality Control Test Reports: Submit written test reports to include the following:

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.
4. Indicate overall system resistance to ground.
5. Indicate overall Telecommunications system resistance to ground.

1.06 **CLOSEOUT SUBMITTALS**

A. Project Record Documents

1. Submit under provisions of Division 26 “Electrical General Requirements”.
2. Accurately record actual locations of grounding electrodes and connections to building steel.

1.07 **QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

C. Comply with ANSI/TIA/EIA-607 “Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications”.

D. Comply with ANSI/IEEE 1100 -1992 “Powering and Grounding Sensitive Electronic Equipment”.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Grounding Conductors and Cables:

a. Refer to Division 26 Section “Conductors and Cables”.

2. Grounding Rods:
    a. American Electric-Blackburn.
    b. Apache Grounding/Erico Inc.
    c. Chance/Hubbell.
3. Mechanical Connectors:
    a. American Electric-Blackburn.
    b. Burndy.
    c. Chance/Hubbell.
4. Exothermic Connections:
    a. Cadweld.
5. Compression-type Connectors:
    a. Burndy HyGround
    b. Blackburn EZ Ground.
    c. Panduit.

2.02 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."

B. Material: Aluminum, copper-clad aluminum, and copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, stranded, copper unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:
    1. Solid Conductors: ASTM B 3.
    2. Assembly of Stranded Conductors: ASTM B 8.

G. Copper Bonding Conductors: As follows:
    1. Bonding Conductor: Stranded copper conductor; size per the NEC.
    2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.

H. Electrical Grounding Busbar
    1. 24” (min) x 2” x ¼” tin plated, copper busbar with two rows of ¼” x 20 tapped holes 1” on center.

I. Telecommunications Main Grounding Busbar (TMGB)
    1. 48” (min) x 4” x ¼” tin plated, copper busbar with three rows of ¼ x 20 tapped holes 1” on center.

J. Telecommunications Grounding Busbar (TGB)
    1. 12” (min) x 2” x ¼” tin plated, copper busbar with two rows of ¼ x 20 tapped holes 3” on center.

K. Telecommunications Bonding Backbone (TBB)
    1. Minimum No. 2 AWG insulated stranded copper.

L. Telecommunications Bonding Conductors

1. Minimum No. 6 AWG insulated stranded copper.

2.03 **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, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected for the specific application per manufacturer's written instructions.

D. Compression-Type Connectors: Pure, wrought copper, per ASTM B187.

2.04 **GROUNDING ELECTRODES**

A. Ground Rods: Copper-clad steel.

1. Size: 5/8 in diameter.

2. Length: 120 inches.

PART 3 EXECUTION

3.01 **EQUIPMENT GROUNDING**

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

C. Underground Grounding Conductors: No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

D. In raceways, use insulated equipment grounding conductors. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.

1. Where existing branch circuits are using conduit as equipment grounding conductor and are extended, provide grounding bushing on existing conduit and provide new equipment grounding conductor with new branch circuit.

E. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.

F. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

G. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

H. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a separate equipment grounding conductor with supply branch-circuit conductors. Bond pole and foundation reinforcing steel to equipment ground conductor.

J. Verify specific equipment grounding requirements with the manufacturer’s recommendations.

3.02 **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.

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: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations

1. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
2. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

D. 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.

E. 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 or UL 486B as applicable.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Connections shall be non-reversible. 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.

G. 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.

3.03 INSTALLATION

A. Equipotential Ground: Interconnect grounding electrodes to form one, electrically continuous, equipotential grounding electrode system. Grounding electrodes to be interconnected include:

1. Metal Underground Water Service Pipe.
2. Metal In-Ground Support Structure.
3. Concrete Encased Electrode.
4. Ground Rods.

B. Metal Underground Water Service Pipes in direct contact with the earth for 10 feet or more: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to all metal water service entrances to building including fire protection water service entrance. Connect grounding conductors to 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.

C. Metal in-ground support structure in direct contact with the earth vertically for 10 feet or more, with or without concrete encasement: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to at least one metal in-ground support structure, or as otherwise indicated. Connect grounding conductors to metal in-ground support structure by exothermic welds. Bond metal grounding conductor conduit or sleeve to conductor at each end.

D. Concrete Encased Electrode: Fabricate in accordance with NFPA 70:

1. Provide a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts.

3. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

E. Ground Rods: 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.

1. Verify that final backfill and compaction has been complete before driving ground rods.

2. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

3. Interconnect ground rods with grounding electrode conductors. Use exothermic welds or non-reversing compression-type connectors, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

F. Grounding Conductors: 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. Install in conduit where routed above grade.

1. Aluminum and copper-clad aluminum conductors shall not be used in direct contact with masonry, within 18 inches of the earth, or where subject to corrosive conditions.

G. 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 or non-reversing compression-type 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.

H. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

I. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

J. Separately Derived AC Power Systems: Ground separately-derived ac power system neutrals including distribution transformers and uninterruptible power supplies to grounding electrodes per NFPA 70.

K. Grounding Bus:

1. Install grounding bus in the locations listed below and elsewhere as indicated:

a. Electrical equipment rooms.

b. Telephone equipment rooms.

c. Rooms housing service equipment.

2. Use insulated spacer; space 2 inch from wall and support from wall 12 inches above finished floor, unless otherwise indicated.

L. Equipment Grounding: Provide a permanent and continuous bonding of conductor enclosures, equipment frames, power distribution equipment ground busses, cable trays, metallic raceways, and other non-current carrying metallic parts of the electrical system.

M. Bond together metal building elements not attached to grounded structure; bond to ground.

N. Provide a flexible braid bonding jumper at each set of columns at expansion joints.

3.04 **UNDERGROUND DISTRIBUTION SYSTEM GROUNDING**

A. Manholes and Handholes: Install a driven ground rod close to wall, inside manhole, 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 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 all 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. 4 AWG minimum conductor. Train 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 circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with transformers/substations by connecting them to underground cable and grounding electrodes. Use not less than a No. 2 AWG conductor for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.05 **TELECOMMUNICATIONS GROUNDING**

A. Telecommunications Grounding System: The telecommunications grounding system shall consist of:

1. Telecommunications Main Grounding Busbar (TMGB) located in the main telecommunications room near the telecommunications service entrance. Bond to the main building electrical grounding electrode system via a No. 3/0 AWG copper ground conductor.

2. A Telecommunications Grounding Busbar (TGB) in each telecommunications room, cabinets, etc.

3. A Telecommunications Bonding Backbone (TBB) tying together the TMGB and each TGB.

4. Bonding of all equipment racks, raceways, non-current carrying metallic equipment and surge protection devices within the telecommunications room to the TGB’s or TMGB using approved bonding conductors. Each piece of equipment shall be bonded individually directly to the ground bus.

B. All bonding connections shall be installed at an accessible location for inspection and maintenance.

C. All telecommunications bonding connections shall be of an approved mechanical type connection. Do not use exothermic welds unless specifically indicated on the Drawings.

D. The physical routing shall, in general, follow the same path as the backbone cable system.

E. Bond each TGB directly to the building steel with a No. 6 AWG conductor.

F. Do not use TGB's as a power system ground connection unless specifically noted on the Drawings.

G. All bonding connectors and conductors shall be UL listed for the purpose intended.

H. TMGB and TGB installation: Use insulated spacer; space 2 inch from wall and support from wall 12 inches above finished floor, unless otherwise indicated.

I. Individually bond each piece of non-current carrying metallic equipment in the Telecommunications Room to the TGB.

J. Install continuous cable from the TMGB to the furthest TGB. Bond all TGB's to TBB with bare No. 3/0 AWG copper ground conductor and T-tap grounding hardware.

3.06 **FIELD QUALITY CONTROL**

A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"

1. Inspect grounding and bonding system conductors and connections for tightness and proper installation and for compliance with the Drawings and Specifications.

2. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.

b. 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.

c. Perform tests, by the fall-of-potential method according to IEEE 81. Instrumentation utilized shall be as defined in Section 12 of IEEE 81 and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that curves flatten in the 62% area of the distance between the item under test and the current electrode.

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.

a. Equipment Rated 500 kVA and Less: 10 ohms.

b. Equipment Rated 500 to 1000 kVA: 5 ohms.

c. Equipment Rated More Than 1000 kVA: 3 ohms.

d. Substations and Pad-Mounted Switching Equipment: 5 ohms.

e. Manhole Grounds: 10 ohms.

f. The telecommunications grounding system shall have a maximum resistance of 1 ohm as measured from the TMGB ground to earth ground.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.07 **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 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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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 the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

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.

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 **QUALITY ASSURANCE**

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

B. Comply with NFPA 70.

1.06 **COORDINATION**

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.01 **SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

a. Allied Tube & Conduit; a part of Atkore International.

b. B-Line, by Eaton.

c. GS Metals Corp.

d. Pentair Electrical & Fastening Solutions.

e. Thomas & Betts Corporation.

f. Unistrut; a part of Atkore International.

g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. 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: Subject to compliance with requirements, provide products by one of the following:

1) B-Line by Eaton.
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.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

2.03 ROOF MOUNTED CONDUIT AND EQUIPMENT SUPPORTS

A. General: Shop- or field- fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted conduit and equipment.

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

1. B-Line by Eaton; Dura-Blok.
2. MIRO Industries.
3. Pentair Electrical & Fastening Solutions; Caddy Pyramid.
4. Pipe Pier Support Systems; Pipe Piers.

C. Adjustable Compact Stand: Recycled rubber base unit with integral threaded coupling capable of accepting 3/8-16 threaded rod, or 1-5/8 inch by 1-5/8 inch metal strut and various supporting elements.

D. Multiple-Conduit and Equipment Stand: Assembly of bases, vertical and horizontal members, and conduit supports, for roof installation without membrane penetration.

1. Bases: One or more adjustable compact stand bases.
2. Vertical Members: Two or more protective-coated-steel channels.
3. Horizontal Member: Protective-coated-steel channel.
4. Supports: Standard strut clamps, hangers, and accessories.

2.04 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 6 Section "Rough Carpentry." Plywood sheets shall be free of all voids. Plywood shall have a minimum of two coats of fire-resistant, non-conducting paint applied to all sides of all sheets. Provide flush hardware and supports to mount

plywood to wall. The provided hardware shall have sufficient strength to carry all anticipated loads including, but not limited to cabling, cable management and equipment racks.

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. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with:

a. Two-bolt conduit clamps

b. Single-bolt conduit clamps

c. Single-bolt conduit clamps using spring friction action for retention in support channel.

D. Support single runs of MC cable using spring-steel clamps from suspended ceiling hangers, hanger wire or building structure at intervals not to exceed three feet. Do not support MC cable from ceiling grid.

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. 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 support systems attached to substrate.

E. Slotted support systems applications:
1. Indoor dry and damp Locations: Painted Steel
2. Outdoors and interior wet locations: Galvanized Steel

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

G. Do not fasten supports to floor decks, roof decks, pipes, ducts, mechanical equipment, or conduit.

H. Obtain permission from Architect/Engineer before using powder-actuated anchors.

I. Obtain permission from Architect/Engineer before drilling or cutting structural members.

J. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

K. Install surface-mounted cabinets and panelboards with minimum of four anchors.

L. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

M. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

N. The Contractor shall replace all supports and channels that sag, twist, and/or show signs of not providing proper structural support, to the equipment, it is intended for, as determined by the Owner and Architect/Engineer. All costs associated with replacing supports and steel channels shall be incurred by the Contractor.

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.

3.04 INSTALLATION OF ROOF MOUNTED SUPPORTS

A. Install in accordance with manufacturer’s instructions.

B. If gravel top roof, gravel must be removed around and under support.

C. Consult roofing manufacturer for roof membrane compression capacities. If required, a compatible sheet of roofing material (rubber pad) may be required under rooftop support to disperse concentrated loads and add further membrane protection.

D. Utilize properly sized clamps and accessories to suit conduit sizes.

E. Provide vertical steel channel members as required for elevated conduit supports where required for clearances, coordination with other roof mounted systems or derating.

3.05 **CONCRETE BASES**

A. Provide concrete bases for all floor mounted electrical equipment.

B. Provide concrete bases for all exterior, grade level electrical equipment, and where indicated.

C. Base/Pad Construction:

1. Construct per manufacturer's recommendations for particular equipment, including suggested piers and dowel rods.

2. Interior concrete bases shall have a minimum depth of 4" unless other indicated or recommended by the manufacturer.

3. Exterior concrete bases shall have a minimum depth of 8" unless other indicated or recommended by the manufacturer.

4. Construct concrete bases for primary and secondary power distribution equipment per requirements of the electrical utility, where submitted for its review.

D. Anchor equipment to base per both supports and equipment manufacturer's instructions.

E. Coordinate conduit openings and sleeve locations in base with requirements of equipment to be supported.

3.06 **BACKBOARDS**

A. A minimum of two walls (or as indicated on drawings) shall be covered with plywood backboards to a minimum 8'-6" above finished floor in all Telecommunication Rooms and similar spaces and as indicated on Drawings.

B. Securely fasten backboard to wall using appropriate hardware and mount at all four corners, minimum. Securely fasten backboard to wall-framing members (studs).

C. Provide adequate backboard space to allow a clean and workable arrangement for telephone and data connections.

3.07 **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.

B. Touchup: Comply with requirements in Division 09 painting Sections, Section "High-Performance Coatings" 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.

END OF SECTION

SECTION 26 0533 - RACEWAYS AND BOXES

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section, “Underground Ducts and Raceways for Electrical Systems” for exterior duct banks, manholes and underground utility construction.
2. Division 07 Section, “Penetration Firestopping” for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
3. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings, and for access floor boxes and service poles.
4. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. RNC: Rigid nonmetallic conduit.

H. PVC: Polyvinyl Chloride.

I. HDPE: High Density Polyethylene.

J. RTRC: Reinforced Thermosetting Resin Conduit

1.04 **ACTION SUBMITTALS**

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

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. Comply with NFPA 70.

1.06 **COORDINATION**

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.01 **METAL CONDUIT AND TUBING**

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

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube Triangle Century.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. International Metal Hose.
6. Electri-Flex Co
7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
8. LTV Steel Tubular Products Company – Manhattan/CDT/Cole-Flex.
9. Maverick.
10. O-Z Gedney; unit of General Signal.
11. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit, IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel or Aluminum.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

2. Fittings for EMT: Steel, compression type.

3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.02 NONMETALLIC CONDUIT AND TUBING

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

1. American International.

2. Anamet Electrical, Inc.; Anaconda Metal Hose.

3. Arnco Corp.

4. Cantex Inc.

5. Certainteed Corp.; Pipe and Plastics Group.

6. Condux International.

7. ElecSys, Inc.

8. Electri-Flex Co.

9. Integral.

10. Kor-Kap.

11. Lamson and Sessions: Carlon Electrical Products.

12. Manhattan/CDT/Cole-Flex.

13. RACO; Division of Hubbell, Inc.

14. Scepter.

15. Spiralduct, Inc./AFC Cable Systems, Inc.

16. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

E. LFNC: UL 1660.

F. HDPE: UL 651, ASTM D 3350, ASTM D 1248 Schedule 40.

G. RTRC: Comply with UL 2515A and NEMA TC 14.

2.03 METAL WIREWAYS

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

1. Hoffman.

2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.04 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

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

a. Airey-Thompson Sentinel Lighting: Wiremold Company (The).

b. Thomas & Betts Corporation.

c. Walker Systems, Inc.; Wiremold Company (The).

d. Wiremold Company (The); Electrical Sales Division.

e. Mono-Systems, Inc.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.05 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2. Shall be used in corrosive areas.

D. Floor Boxes: Cast metal, fully adjustable, rectangular.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Shall be used in areas exposed to water.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.06 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.07 **SLEEVE SEALS**

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

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Plastic. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.08 **GROUT**

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

PART 3 EXECUTION

3.01 **RACEWAY APPLICATION**

A. Provide raceways in interior and exterior locations in accordance with the “Raceway Application Matrix” included on the drawings.

B. Boxes and Enclosures, Exterior Aboveground: NEMA 250, Type 3R.

C. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

D. Minimum Raceway Size: 3/4-inch trade size.

E. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
3. EMT: Use compression steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

F. Do not install aluminum conduits in contact with concrete.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 **INSTALLATION**

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. 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.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install temporary closures to prevent foreign matter from entering raceways.

F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

J. Support conduit within 12 inches of enclosures to which attached.

K. Raceways Embedded in Slabs:

1. Raceways embedded in slabs shall be limited to above grade concrete decks. Embedded conduit shall be limited to servicing floor boxes and equipment located in open spaces away from accessible walls.

2. Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover.

3. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

4. Space raceways laterally to prevent voids in concrete.

5. 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.

6. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

7. Conduits shall run flat. Do not allow conduits to cross.

8. Change from non-metallic raceway to rigid steel before turning up out of the concrete and rising above the floor.

L. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.

2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

S. 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.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

U. Provide pull string and 25% spare capacity in every branch circuit conduit.

V. Communications and Signal Cabling Systems Raceways: 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.

1. Electrical condulet (LB’s) are not permitted.
2. Conduits shall have no more than two 90 degree bends between pull points or pull boxes.
3. Conduits shall contain no continuous sections longer than 150 ft. without a pull point/box.
4. Conduit for fiber cabling shall have a bend radius of at least 10 times the internal diameter.
5. Conduit for copper cabling less than 2” shall have a bend radius of at least 6 times the internal diameter. Conduit for copper cabling 2” and larger shall have a bend radius of at least 10 times the internal diameter.
6. All conduit ends shall have an insulated bushing.

W. 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:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where conduits route through, to, or from a hazardous classified space (Class I or II), provide proper seal offs when exiting or entering the hazardous classified space.
3. Where conduits pass between spaces that are maintained at two different vapor pressures.
4. Where otherwise required by NFPA 70.

X. 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 with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

Y. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Flexible Conduit Connections: Comply with NEMA RV3. Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

AA. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals. Provide cover clips to cover space between connecting pieces.

BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

DD. Locate boxes so that cover or plate will not span different building finishes.

EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set floor boxes level and flush with finished floor surface. Trim non-metallic boxes after installation to fit flush with finished floor surface.

HH. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

II. Do not route feeders across roof.

JJ. Provide a pull box (a handhole for outdoor applications) for each conduit run that exceeds 250 feet. Provide two pull boxes (handholes for outdoor applications) for runs that exceed 500 feet.

KK. Route conduits in finished areas with exposed ceilings at underside of structural deck or as high as possible.

LL. Outlet boxes within hazardous locations shall be of the proper class and division as noted in the N.E.C.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in Division 2 Section "Earthwork."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.04 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. 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.

E. 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.

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. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.05 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.06 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop Systems."

3.07 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.08 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 26 0553 - ELECTRICAL IDENTIFICATION

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

1.04 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.05 COORDINATION

A. 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.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. 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.

B. Color for Printed Legend:

1. Power Circuits: Black letters on an orange field.
2. Legend: Indicate system or service and voltage, if applicable.

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.

2.02 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.03 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.04 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. 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: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.05 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 3/8 inch.

B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.06 **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.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.07 **WIRING DEVICE IDENTIFICATION**

A. Description: Self adhesive label with black upper case letters on clear polyester label, font size 7.

PART 3 EXECUTION

3.01 **APPLICATION**

A. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service and Feeders More Than 400 A: Identify with orange self-adhesive vinyl label.

C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.
2. Security System: Blue and yellow.
3. Telecommunication System: Green and yellow.
4. Control Wiring: Green and red.

D. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape and marker tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

E. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number as indicated on Drawings. Identify control circuits by control wire number as indicated on shop drawings.

F. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.

G. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.

H. 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.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.

b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

K. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label mechanically secured.

b. Outdoor Equipment: Stenciled.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled: If included on project. All items may not be on project.

a. Panelboards, electrical cabinets, and enclosures.

b. Access doors and panels for concealed electrical items.

c. Electrical switchgear and switchboards.

d. Transformers.

e. Electrical substations.

f. Emergency system boxes and enclosures.

g. Motor-control centers.

h. Disconnect switches.

i. Enclosed circuit breakers.

j. Motor starters.

k. Variable Frequency Controllers

l. Push-button stations.

m. Power transfer equipment.

n. Contactors.

o. Remote-controlled switches, dimmer modules, and control devices.

p. Battery inverter units.

q. Battery racks.

r. Power-generating units.

s. Voice and data cable terminal equipment.

t. Master clock and program equipment.

u. Intercommunication and call system master and staff stations.

v. Television/audio components, racks, and controls.

w. Fire-alarm control panel and annunciators.

x. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.

y. Monitoring and control equipment.

z. Uninterruptible power supply equipment.

aa. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

bb. Breakers or switches at distribution panels.

M. Wiring Device Identification Labels: On each faceplate install circuit designation label that is consistent with panelboard directories, and as-built plan drawings. Apply labels to receptacle faceplates centered below bottom outlet. Apply labels to toggle switch faceplates on backside.

3.02 **INSTALLATION**

A. Verify identity of each item before installing identification products.

B. Location:

1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

2. Conduit Markers: Provide identification for each power conduit containing conductors rated 400A or greater.

C. Apply identification devices to surfaces after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208/120-V Circuits:
    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.
    d. Grounded Conductor (Neutral): White.
3. Colors for 480/277-V Circuits:
    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Ground Conductor (Neutral): Grey.
4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

I. Label information arrangement for 3 lines of text.

1. Line one shall describe the panel or equipment. Line one example: “DP-XX,” RP-XX,” “T-XX,” “EF-XX,” etc.
2. Line two shall describe the first disconnecting means feeding this panel or equipment. Line two example: “Fed from DP-XX,” “Fed from RP-XX,” etc.
3. Line three indicates that location of the disconnecting means as identified in line two. Line three example: “First Floor Elect. Rm #XXX.”
4. Line four shall include “Via T-XX” when panel or equipment is fed from a transformer.

J. Examples:

RP-1A FED FROM DP-1A ELECTRICAL ROOM A100 VIA T-1A	EF-1 FED FROM MCC-1A MECHANICAL ROOM F101	LP-1A LOCATED IN ELECTRICAL ROOM A100

K. Fusible Enclosed Switches and Distribution Equipment: Install self-adhesive vinyl label indicating fuse rating and type on the outside of door on each fused switch.

L. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

M. Degrease and clean surface to receive nameplates.

N. Install nameplate and labels parallel to equipment lines.

O. Secure nameplate to equipment front using screws.

P. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

Q. Identify conduit using field painting where required.

R. Paint red colored band on each fire alarm conduit and junction box.

S. Paint bands 10 feet on center, and 4 inches minimum in width.

END OF SECTION

SECTION 26 0573 - OVERCURRENT DEVICE COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018, Annex D prepared by the electrical equipment manufacturer.

C. The scope of the studies shall include all new distribution equipment supplied by the equipment manufacturer under this contract as well as all directly affected existing distribution equipment at the customer facility.

1.03 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 -National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition.

1.04 **ACTION SUBMITTALS**

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.05 **INFORMATIONAL SUBMITTALS**

A. The results of the short-circuit, protective device coordination, and arc flash hazard analysis studies shall be summarized in a final report. Report shall be provided on electronic media. All literature shall be combined in one document and shall be properly bookmarked with all applicable sections.

B. The report shall include the following sections:

1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Details of the incident energy and flash protection boundary calculations.
7. Recommendations for system improvements, where needed.
8. One-line diagram.

C. Arc flash labels shall be provided in full size representation in PDF format and submitted with the study.

D. The report shall be signed and sealed by the Professional Engineer supervising the study.

1.06 **QUALIFICATIONS**

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies and registered in the state where the project is located.

D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.07 **COMPUTER SOFTWARE PROGRAMS**

A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:

1. EDSA Micro Corporation.
2. SKM Systems Analysis, Inc.
3. ESA Inc.
4. CGI CYME.
5. Operation Technology, Inc.

PART 2 PRODUCTS

2.01 **STUDIES**

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.02 **DATA COLLECTION**

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data to satisfy the study requirements.

2.03 **SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY**

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated

4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Tabulations of calculated quantities
6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
1. Electric utility's supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.04 **PROTECTIVE DEVICE COORDINATION STUDY**

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:
1. Electric utility's overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable

8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. For emergency and standby distribution paths, provide selective coordination tables to demonstrate tested upstream/downstream breaker pairs selectively coordinate across the full range of over currents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associate with those fault currents.

2.05 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.06 **REPORT SECTIONS**

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).

2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.

3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X”d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.

4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a. Voltage

b. Calculated fault current magnitude and angle

c. Fault point X/R ratio

d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a. Voltage

b. Calculated symmetrical fault current magnitude and angle

c. Fault point X/R ratio

d. Calculated asymmetrical fault currents

1) Based on fault point X/R ratio

2) Based on calculated symmetrical value multiplied by 1.6

3) Based on calculated symmetrical value multiplied by 2.7

e. Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a. Voltage

b. Calculated symmetrical fault current magnitude and angle
c. Fault point X/R ratio
d. No AC Decrement (NACD) Ratio
e. Equivalent impedance
f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
a. Current transformer ratio
b. Current setting
c. Time setting
d. Instantaneous setting
e. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
a. Adjustable pickups and time delays (long time, short time, ground)
b. Adjustable time-current characteristic
c. Adjustable instantaneous pickup
d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations
1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 EXECUTION

3.01 FIELD ADJUSTMENT

A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify design engineer in writing of any required major equipment modifications.

3.02 ARC FLASH WARNING LABELS

A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label for equipment where arc incident energy is calculated shall include the following, at a minimum:

1. Location designation
2. Nominal system voltage
3. Arc flash boundary
4. Incident energy
5. Working distance
6. Engineering report number, revision number and issue date.

D. The label for equipment where arc incident energy is not calculated shall include the following, at a minimum:

1. Location designation
2. Nominal system voltage
3. Arc flash boundary from NFPA 70E 2018 Table 130.7(C) 15(a)
4. Arc flash PPE category from NFPA 70E 2018 Table 130.7(C) 15(a)
5. Engineering report number, revision number and issue date.

E. Labels shall be machine printed, with no field markings.

F. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and 208 volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

G. Labels shall be field installed by the contractor.

END OF SECTION

SECTION 26 0923 - LIGHTING CONTROL DEVICES

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following lighting control devices:

1. Outdoor and indoor photoelectric control.
2. Occupancy sensors.
3. Wall digital time switches.
4. Low voltage key switch.
5. Stand-alone room controller systems.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements”.
2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.03 REFERENCES

A. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.

B. IEEE C136.10: Standard for Roadway Lighting Equipment Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing.

C. NEMA ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC Part 8: Disconnect Devices for Use in Industrial Control Equipment.

D. NFPA 70: National Electrical Code.

E. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

F. UL 486B: Wire Connectors for Use with Aluminum Conductors.

G. UL 773: Plug-in, Locking Photocontrols for Use with Area Lighting.

H. UL 773A: Nonindustrial Photoelectric Switches for Lighting Control.

I. UL 917: Clock Operated Switches.

J. UL 1449: Surge Protective Devices.

K. UL 1598: Luminaires.

L. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.04 **DEFINITIONS**

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

C. ULTRASONIC: Active emission of at least 35 kHz sound waves, using Doppler reflectance to detect motion.

D. MICROPHONIC: Passive reception to listen for continued occupancy, with circuitry to filter out white noise.

E. MULTI-Tech: Using PIR and ultrasonic or microphonic technologies in one sensor.

1.05 **SUBMITTALS**

A. Product Data: For each type of product indicated including physical data and electrical performance.

B. Shop Drawings: Show installation details for occupancy, light-level sensors, and room controller systems.

1. Lighting plan showing location, orientation, and coverage area of each sensor.

2. Lighting plan showing location of each room controller, sensor, wall station, and other system components.

3. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:

1. Description of operation and servicing procedures.

2. List of major components.

3. Recommended spare parts.

4. Programming instructions and system operation procedures.

1.06 **QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.07 **COORDINATION**

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, fire-suppression system, and partition assemblies.

B. Coordinate interface of lighting control devices with temperature controls specified in Division 23.

1.08 **DELIVERY, STORAGE, AND HANDLING**

A. Deliver products to the site under provisions of Division 26 Section “Electrical General Requirements”.

B. Store and protect products under provisions of Division 26 Section “Electrical General Requirements”.

PART 2 PRODUCTS

2.01 **GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS**

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.02 **OUTDOOR PHOTOELECTRIC CONTROL**

A. Manufacturers:

1. Intermatic, Inc.
2. Square D.
3. TORK.

B. General

1. Provide fully-gasketed, weathertight enclosure constructed of die cast zinc, with one-half inch conduit nipple for mounting purposes, and with positioning lug to permit full 360-degree adjustable orientation of photocell.
2. Provide hermetically-sealed, one-inch-diameter, cadmium sulphide photoelectric cell with manual, light level selector.
3. Provide photoelectric control suitable for an operating temperature range of minus 40 degrees F to plus 140 degrees F.

C. Description: Solid state, with SPST dry contacts rated for 2000 W tungsten or 1800 VA ballasted load, to operate connected load, relay, contactor coils, or microprocessor input, and complying with UL 773A.

1. Light-Level Monitoring Range: Adjustable turn-on range of 1 to 5 footcandle and adjustable turn-off range of 3 to 15 footcandle, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: Adjustable delay up to two minutes to prevent false operation.
3. Contacts: Normally closed, fail on.
4. Electrical: Provide photocell with operating voltage rated to switch the load directly unless otherwise indicated.
5. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
6. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

7. Provide hermatically-sealed, one inch diameter, cadmium sulphide photoelectric cell with manual, 2 to 50 footcandle, light level selector.

2.03 **INDOOR PHOTOELECTRIC CONTROL**

A. Manufacturers:

1. Wattstopper LS-101.
2. Sensorswitch CM-PC.

B. Photoelectric Sensor: Solid-state, light-level sensor unit utilizing an internal photoconductive cell to detect changes in lighting levels and capable of controlling any lighting source.

1. Housing: White, thermoplastic, tamper resistant, ceiling mount.
2. Sensor shall operate on 24V DC power through a control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
3. Light-Level Monitoring Range: 10 to 200 footcandle, with an adjustment for turn-on and turn-off levels within that range.
4. Deadband: Adjustable range of 10 to 300%.
5. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
6. Indicator: Two LEDs to indicate the beginning of on and off cycles.
7. Manual override function.
8. Provide indoor photoelectric switches and control units from single manufacturer.
9. Provide indoor photoelectric switches from same manufacturer as occupancy sensors.
10. Provide all control units and relays required to interface with occupancy sensors as required.

C. Indoor Photoelectric Sensor Control Units:

1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.
    a. Control units shall be provided as required to power indoor photoelectric sensor, control lighting loads and provide a minimum of one auxiliary contact.
    b. Sensor control units shall mount external to 4” sq junction box in the ceiling space. Wiring between control unit and photoelectric switch shall be plenum rated.
    c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.
    d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.
    e. It is acceptable to provide controls and auxiliary contacts as required integral to the sensor, provided all required contacts are provided.
    f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.04 **OCCUPANCY SENSORS**

A. General

1. Coordinate occupancy sensor locations, coverages and required quantities with manufacturer’s recommendations. Coverage areas indicated on the Drawings are for minor motion (6 to 8 inches of hand movement). Provide additional occupancy sensors and

control units as required to achieve complete minor motion coverage of the space indicated.

2. Adjust occupancy sensors and test that complete minor motion coverage is obtained in accordance with Part 3. Provide written confirmation of testing to owner, architect and engineer.
3. Provide occupancy sensors with a bypass switch to override the “ON” function in the event of sensor failure.
4. Provide occupancy sensors with an LED indicator indicating when motion is being detected during testing and normal operation of the sensor.
5. Provide occupancy sensors and occupancy sensor control units from single manufacturer.

B. Wall Switch Passive Infrared Occupancy Sensor

1. Manufacturers:
   a. Wattstopper PW-100.
   b. Hubbell Building Automation SOM 101.
   c. Greengate OSW-P-MV or ONW-P-MV.
   d. Sensorswitch WSD.
2. Description: Wall mounted, 180° coverage, passive infrared sensing occupancy sensor.
   a. Electrical Characteristics: Capable of switching up to 800W fluorescent or incandescent lighting loads at 120V and 1200 watts fluorescent loads at 277V.
   b. Functions: Automatic ON/Automatic OFF, or Manual ON/Automatic OFF operation, field selectable. Integral manual override pushbutton switch.
   c. Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 30 minutes.
   d. Device Body: White, plastic with momentary on/off override pushbutton designed to mount in a standard switch box with “decora” style switch plate.
3. Dual Level Switching: Provide occupancy sensor capable of controlling two switch legs independently where dual level switching is indicated.
   a. Manufacturers:
      1) Wattstopper PW-200.
      2) Hubbell Building Automation SOM-102.
      3) Greengate OSW-P-DMV or ONW-P-DMV.
      4) Sensorswitch WSD-2P.

C. 360° Ceiling Mounted Dual Technology Occupancy Sensor

1. Manufacturers:
   a. Wattstopper DT 300
   b. Hubbell Building Automation “OMNI-DT” Series.
   c. Greengate OAC-DT.
   d. Sensorswitch CM-PDT-R.
2. Description: Ceiling mounted, 360°coverage, multi-tech sensing occupancy sensor.
   a. Housing: White, thermoplastic, tamper resistant ceiling mount.

b. Functions: Automatic ON must sense motion from both ultrasonic and infrared sensing elements. Either technology shall maintain ON, with adjustable time delays.

c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.

d. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.

e. Manual override function.

D. 110° Wall Mounted Dual Technology Occupancy Sensor

1. Manufacturers:

a. Wattstopper DT-200

b. Hubbell Building Automation “LO-DT” Series.

c. Greengate OAWC-DT-120.

d. Sensorswitch WV-PDT-R/WV-BR.

2. Description: Wall mounted, 110° coverage, multi-tech occupancy sensor.

a. Housing: White, thermoplastic, tamper resistant with swivel bracket for wall or ceiling mounting.

b. Functions: Automatic ON must sense motion from both sensing elements. Either technology shall maintain ON, with adjustable time delays.

c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 15 minutes.

d. Sensor Orientation: Orient sensor in room such that sensor will not detect motion through open door which could cause false activation.

e. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.

f. Manual override function.

E. 360° Ceiling Mounted Ultrasonic Occupancy Sensors

1. Manufacturers:

a. Wattstopper “WT” Series.

b. Hubbell Building Automation “OMNI-US” Series.

c. Greengate OAC-U.

d. Sensorswitch CM MPT-10.

2. Description: Ceiling mounted, 360° coverage, ultrasonic or microphonics sensing occupancy sensor.

a. Housing: White, thermoplastic, tamper resistant.

b. Adjustments: Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 15 minutes.

c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.

d. Manual override function.

F. 360° Ceiling Mounted Passive Infrared Occupancy Sensor.

1. Manufacturers:

a. Wattstopper CI-200.

b. Hubbell Building Automation OMNI-IR.

c. Greengate OAC-P.

d. Leviton OSC04-I0W.

2. Description: Ceiling mounted, 360° coverage, infrared sensing occupancy sensor.

a. Housing: White, thermoplastic, tamper resistant ceiling mount.

b. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.

c. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.

d. Manual override function.

G. Occupancy Sensor Control Units:

1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.

a. Control units shall be provided as required to power ceiling mounted occupancy sensors, control lighting loads and provide a minimum of one auxiliary contact.

b. Occupancy sensor control units shall mount external to 4” sq junction box in the ceiling space. Wiring between control unit and occupancy sensor shall be plenum rated.

c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.

d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.

e. It is acceptable to provide controls and auxiliary contacts as required integral to the ceiling sensor, provided all required contacts are provided.

f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.05 LOW VOLTAGE KEY SWITCH

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

1. Cooper Lighting Solutions

2. Acuity

3. Lutron

4. Hubbell

5. Crestron Controls

B. Low Voltage Digital Key Switch:

1. Low voltage momentary key switch; available in white, ivory, grey and black; compatible with wall plates with decorator opening. Key stations shall include the following features:

a. RJ-45 ports for connection to the power relay pack.

b. Low voltage digital key switch shall be delivered with pre-defined functions including, on, off. No additional configuration shall required to provide a fully functional system. Systems that require configuration out of the box shall not be acceptable.

2. Provide compatible power relay pack.

2.06 **ROOM CONTROLLER SYSTEM**

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

1. Cooper Lighting Solutions
2. Acuity
3. Lutron
4. Hubbell
5. Crestron Controls

B. General

1. System shall be fully functional out-of-the-box to the connected devices in the space without commissioning or the use of any tools. System shall not require a dedicated PC or a dedicated cloud connection.
2. Factory virtual support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.
3. Coordinate sensor locations, coverages and required quantities with manufacturer's recommendations. Provide all sensors and components as required to achieve complete coverage and functionality of the space indicated.
4. Provide system with functionality to override the "ON" function in the event of sensor, controller, or component failure.
5. System shall have an isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options.
6. System components shall connect together using CAT 5e cables with RJ45 connectors, which provide both data and power to room devices, to form the local network. Features of the Room Controller local network include:
   a. Default functionality of occupancy sensors, wallstations, daylight sensors, receptacle controls, BMS status output and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
   b. Replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
7. Room Controller shall support BACnet/IP and BACnet/MSTP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
   a. BACnet/MSTP shall support a minimum of 50 additional BACnet MS/TP controllers in addition to the Expansion I/O modules.
   b. BACnet/MSTP shall support 9600 to 115200 baud.
   c. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
   d. System controller must support BACnet/IP Broadcast Management Device (BBMD) and Foreign Device Registration (FDR).

C. Room Controller:

1. Room Controller shall be a multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
2. NEMA 1 metallic enclosure that includes normal power line voltage section, emergency power line voltage section, and low voltage section Including knockouts for direct conduit connection.
3. Voltage rating of 120/277 VAC, 60 Hz.
4. Minimum of six low voltage connections using standard CAT 5e cables and RJ45 connectors for local network connections of wallstations, sensors, lighting controls, and receptacle controls.
5. On/Off/Dimming Room Controllers shall include three relay, switching zone configuration or three relay, three 0-10V dimming zone configuration as indicated on drawings.
6. Provide UL 924 listed emergency lighting relay where indicated on drawings.

D. Daylight Sensor:

1. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
2. Three light level ranges: Low (3-300 Lux), High (30-3000 Lux), And Direct Sun (300-30000 Lux).
3. Capability of controlling up to three daylight zones.
4. Infrared (IR) transceiver for daylight sensor range and daylight zone gain adjustments via handheld remote programmer.
5. RJ45 Port for Connection to Room Controller Local Network.
6. Adjustable sensor with mounting bracket to accommodate multiple mounting methods and building materials. The daylight sensor may be mounted on a ceiling tile, skylights, wall, lighting fixture, or backbox.
7. Device automatically establishes dimming set-points upon power up without any programming. Optional calibration using the wireless IR handheld programmer.

E. Occupancy Sensor:

1. Shall incorporate non-volatile power failure memory. Should power be interrupted and subsequently restore, settings and parameters saved in protected memory shall not be lost.
2. Designed and tested to withstand discharges of 154,000 volts per IEC 801-2 without impairment of performance.
3. Products tested to NEMA WD7-2011 Occupancy Motion Sensors Standards.
4. Sensor shall have time delays from 10 to 30 minute and shall automatically adjust time delay and sensitivity settings.
5. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation. LED’s shall indicate PIR detection and Ultrasonic detection.
6. All sensors shall have readily accessible, user adjustable setting for time delay and sensitivity. Setting shall be located on the sensor and shall be recessed to limit tampering.
7. All sensors shall be Class 2 devices and shall be provided with all necessary mounting hardware and instructions.

8. Two RJ45 Ports for Connection to Room Controller Local Network.
9. Device calibration and features:
    a. Sensitivity - 0-100% in 10% increments.
    b. Time delay - 1-30, self-adjusts to 10 min based on room occupancy.
    c. Test mode - Fifteen second time delay.
    d. Detection technology - PIR, Ultrasonic or Dual Technology activation and/or re-activation.
    e. Walk-through mode.
    f. Ultrasonic and Dual Technology Sensors utilize two independent sensor detection circuits simultaneously to ensure optimum performance, regardless of location or proximity to walls and structures.
    g. Ultrasonic and Dual Technology Sensors utilize Variable Drive Circuitry (VDC) in cases of over saturation from misapplication, which automatically adjusts the volumetric output without reducing detection capability. Systems that reduce detection coverage area shall not be acceptable.
    h. Automatically and continually self-adjust ultrasonic frequency to ignore specific frequency, continuous noise from airflow to prevent detuning which can lead to inadvertent lights out. Sensors that require detuning shall not be acceptable.
    i. All load parameters including Automatic On/Manual On, blink warning and daylight enable/disable when daylight sensors are pre-defined with the Room Controller local network.
10. Manual override of controlled loads.

F. Digital Wallstations:
1. Low voltage momentary pushbutton switches in 2, 3, 4, 5 and 6 button configuration; available in white, ivory, grey and black; compatible with wall plates with decorator opening. Wallstations shall include the following features:
    a. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
    b. Intuitive button labeling to match application and load controls.
    c. Pre-defined digital button configurations. Each wallstation to be shipped with pre-defined digital button configurations which are automatically sensed by the connected Room Controller and mapped to specific load controls for immediate out of the box functionality.
2. Two RJ-45 ports for connection to the Room Controller local network.
3. Room Controller digital wallstations shall be delivered with pre-defined functions including, on, off raise, lower, manual and scene control. No additional configuration shall required to provide a fully functional system. Systems that require configuration or load binding and do not deliver maximum energy savings out of the box shall not be acceptable.
4. Wallstations scene control shall be adjustable through a simple interface or handheld control for flexibility of lighting scenes. This personal remote shall allow individual zone control, scene control and scene setting capabilities.
5. Optional custom labeling shall be provided as indicated on the drawings.

G. Handheld Remote Controls:

1. Battery-operated handheld for system and sensor configuration. Remote controls shall include the following features:
    a. Two-way infrared (IR) transceiver for line of sight up to 30 feet.
    b. Three intuitive daylight sensor range pushbuttons.
    c. LED confirms button press.
    d. Inactivity timeout to save battery life.

H. Emergency Lighting:

1. Where indicated, provide Room Controller with emergency relay. Upon loss of normal power the UL 924 output will force the emergency lighting On and to full brightness (if dimming) until normal power is restored. Features Include:
    a. 120/277VAC, 50/60 Hz, 3 amp driver rating.
    b. Push the "All Off' button on any wallstation four times, will turn off normal lighting and force UL 924 emergency output On and full bright.
    c. Auxiliary input for remote Alert Mode (All On, and full bright).

PART 3 EXECUTION

3.01 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION

A. Mount photocell on roof or parapet to ½” GRS conduit, supported to building structure below. Coordinate roof penetration with roofing contractor.

B. Install photoelectric control oriented in the northeast direction and not within any potential shadows.

C. Adjust photocell sensitivity and delay to meet owner’s requirements. Multiple adjustments may be required, as needed.

3.02 OCCUPANCY SENSOR INSTALLATION

A. Install wall mounted occupancy sensors as noted on plan. Arrange occupancy sensors with adjacent switch devices so that device plates line-up and are equally spaced.

B. Install ceiling mounted sensors at approximate locations as indicated on plan. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.

C. Locate sensors such that motion through open doors will not falsely activate sensors.

D. Do not locate ultrasonic sensors within six feet of supply air diffusers.

E. Locate infrared sensors to avoid obstructions.

F. Provide the services of a manufacturer’s representative for commissioning of occupancy sensor installation. This shall include consultation on layout and location prior to installing sensors, testing of each sensor for compliance with Contract Documents and field adjustment and fine tuning after installation is complete. Provide written confirmation of testing to the Owner, Architect and Engineer.

G. Field adjustments shall take place in the presence of the owner and the engineer. This shall include owner training on adjustment techniques for the occupancy sensors.

3.03 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Conductors and Cables".

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. 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.

3.04 ROOM CONTROLLER INSTALLATION, SERVICE AND COMMISSIONING

A. The control system shall be installed and fully wired as shown on the drawings, shop drawings, and manufacturer’s instructions by the installing contractor. The contractor shall complete all electrical connections to all control circuits.

B. Upon completion of the installation, the system shall be started up and programmed by the manufacturer's factory authorized representative who will verify a complete fully functional system.

C. Adjust sensors and test that complete minor motion coverage is obtained. Provide written confirmation of testing to owner, architect and engineer.

D. Provide written or computer-generated documentation on the system start-up and programming of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities and daylighting setpoints.
2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.).
3. Load parameters (e.g. blink warning, etc.).

E. The electrical contractor shall provide both the manufacturer and the electrical engineer with twenty one working days written notice of the system startup and programming date.

F. System Commissioning:

1. Facilitate the functional testing and verification of the lighting control system by an independent, third party commissioning agent. In compliance with ASHRAE 90.1-2013.
2. Perform commissioning in the presence of the Owner’s representative.
3. Submit functional test plan checklist signed by the commissioning agent.

3.05 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

B. Label time switches and contactors with a unique designation.

3.06 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: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.07 **ADJUSTING**

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION

SECTION 26 0999 - ELECTRICAL TESTING

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements.”
2. Division 26 Section “Conductors and Cables.”
3. Division 26 Section “Medium Voltage Cables.”
4. Division 26 Section “Grounding and Bonding.”
5. Division 26 Section “Central Battery Inverters.”
6. Division 26 Section “Medium-Voltage Transformers.”
7. Division 26 Section “Medium Voltage Switchgear.”
8. Division 26 Section “Enclosed Switches.”
9. Division 26 Section “Enclosed Controllers.”
10. Division 26 Section “Surge Protective Devices”
11. Division 26 Section “Switchboards.”
12. Division 26 Section “Panelboards.”
13. Division 26 Section “Dry Type Transformers (600V and Less).”
14. Division 26 Section “Fuses.”
15. Division 26 Section “Functional Performance Testing for Power and Lighting.”

1.02 SECTION INCLUDES

A. Engage the services of a recognized corporately independent N.E.T.A. certified testing firm to perform inspections and tests as specified herein.

B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. It is the intent of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design Specifications.

D. The test and inspections shall determine suitability for energization.

E. Equipment to be tested and inspected shall be the equipment shown on the one line diagram and schedules as required by part three of each individual Specification Section. In addition, all equipment that is part of an emergency distribution system shall be tested.

1.03 **REFERENCES**

A. All inspections and tests shall be in accordance with the latest version of the following codes and standards except as provided otherwise herein.

1. National Electrical Manufacturer's Association - NEMA
2. American Society for Testing and Materials - ASTM
3. Institute of Electrical and Electronic Engineers - IEEE
4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-2017
5. InterNational Electrical Testing Association - NETA Maintenance Testing Specifications-MTS-2015
6. American National Standards Institute - ANSI C2: National Electrical Safety Code
7. State and Local Codes and Ordinances
8. Insulated Cable Engineers Association - ICEA
9. Association of Edison Illuminating Companies - AEIC
10. Occupational Safety and Health Administration
11. National Fire Protection Association - NFPA
    a. ANSI/NFPA 70: National Electrical Code
    b. ANSI/NFPA 70B: Electrical Equipment Maintenance
    c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
    d. ANSI/NFPA 101: Life Safety Code

1.04 **QUALIFICATIONS**

A. The testing firm shall be corporately independent and function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person and at least 50% of the on site crew shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies in Electrical Power Distribution System Testing.

D. The testing firm shall only utilize technicians who are regularly employed by the firm on a full-time basis for testing services.

E. The Contractor shall submit proof of the above qualifications with bid proposal.

F. The terms test agency, test contractor, testing laboratory, test organization, or contractor test company, shall be construed to mean the testing firm.

G. Acceptable Testing Firms:

1. Potomac Testing; Phone (248) 689-8980.
2. Utilities Instrumentation Services; Phone (734) 424-1200.
3. High Voltage Maintenance Corporation; Phone (248) 305-5596.
4. Powertech Services, Inc.; Phone (810) 720-2280.

5. Power Plus Engineering, Inc.; Phone (800) 765-3120.
6. Premier Power Maintenance, Inc.; (517) 230-6629

1.05 **PERFORMANCE REQUIREMENTS**

A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.

B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

C. The testing firm shall notify the Owner's Representative prior to commencement of any testing.

D. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Engineer. The Electrical Contractor shall correct all defects.

E. The testing firm shall maintain a written record of all tests and shall assemble and certify a final test report.

F. Safety and Precautions

1. Safety practices shall include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act.
   b. Accident Prevention Manual for Industrial Operations, National Safety Council.
   c. Applicable state and local safety operating procedures.
   d. NETA Safety/Accident Prevention Program.
   e. Owner's safety practices.
   f. National Fire Protection Association - NFPA 70E.
   g. American National Standards for Personnel Protection.
2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
3. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

1.06 **TEST INSTRUMENT CALIBRATION**

A. Test Instrument Calibration

1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Instruments shall be calibrated in accordance with the following frequency schedule:
   a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
   b. Laboratory instruments: 12 months
   c. Leased specialty equipment: 12 months (Where accuracy is guaranteed by Lessor)
4. Dated calibration labels shall be visible on all test equipment.
5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.

6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.
7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

B. Field Test Instrument Standards
1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
a. Maintained in good visual and mechanical condition.
b. Maintained in safe, operating condition.

C. Suitability of Test Equipment
1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.07 **TEST REPORTS**

A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:
1. A list of visual and mechanical inspections required by Division 26 Specification Sections in a checklist or similar format.
2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.
3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
4. Record of infrared scan and photos showing potential problem locations.
5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.

B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 **THERMOGRAPHIC SURVEY**

A. Visual and Mechanical Inspection
1. Remove all necessary covers prior to scanning.
2. Inspect for physical, electrical, and mechanical condition.

B. Equipment to be Scanned

1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.

C. Provide report indicating the following:

1. Problem area (location of "hot spot").
2. Temperature rise between "hot spot" and normal or reference area.
3. Cause of heat rise.
4. Phase unbalance, if present.
5. Areas scanned.

D. Test Parameters

1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.

E. Test Results

1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:
   a. Temperature gradients of 37°F to 44.6°F indicate possible deficiency and warrant investigation.
   b. Temperature gradients of 44.6°F to 59°F indicate deficiency; repair as time permits.
   c. Temperature gradients of 61°F and above indicate major deficiency; repair immediately.

END OF SECTION

SECTION 26 1200 - MEDIUM-VOLTAGE TRANSFORMERS

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:

1. Pad-mounted, liquid-filled transformers.

B. Related Sections:

1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.03 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.04 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, utility or manufacturer’s anchorage and base recommendations, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

1.05 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

B. Field quality control test reports.

1.06 CLOSEOUT SUBMITTALS

A. Follow-up service reports.

B. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.07 **QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C2.

C. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.

D. Comply with NFPA 70.

1.08 **DELIVERY, STORAGE, AND HANDLING**

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.09 **PROJECT CONDITIONS**

A. Service Conditions: IEEE C37.121, usual service conditions except for the following:

1.10 **COORDINATION**

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Acme Electric Corporation; Power Distribution Products Division.
2. Eaton; Cooper Power Systems Division.
3. ABB.
4. Siemens Industries, Inc.
5. Square D; Schneider Electric.

2.02 **PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS**

A. Description: ANSI/IEEE C57.12.00, pad-mounted, 2-winding transformers. Stainless-steel tank base.

B. Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

C. Insulation Temperature Rise: Based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.

1. Provide transformers with base kVA 55 deg C, 65 deg C, 75 deg C or dual rated with 55/65, 65/75 or 55/75 deg C rise. Temperature rise and kVA ratings including dual ratings, if specified, shall be as indicated on one line diagrams.

D. Basic Impulse Level: Comply with U.L. 1062.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. High-Voltage Switch: 400 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.

1. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
2. Internal liquid-immersed cartridge fuses.
3. Bay-O-Net liquid-immersed fuses that are externally replaceable without opening transformer tank.
4. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
5. Bay-O-Net liquid-immersed current-limiting fuses that are externally replaceable without opening transformer tank.

H. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

1. Bushing-Well Inserts: One for each high-voltage bushing well.
2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.

I. Accessories:

1. Drain Valve: 1 inch, with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.

J. Finish: Factory-applied finish in manufacturer’s standard green color, undersurfaces treated with corrosion-resistant undercoating.

2.03 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

2.04 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90.

B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
2. Ratios on rated-voltage connection and on tap extreme connections.
3. Polarity and phase relation on rated-voltage connection.
4. No-load loss at rated voltage on rated-voltage connection.

5. Excitation current at rated voltage on rated-voltage connection.
6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. 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.

C. Examine walls, floors, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install transformers and anchor to concrete bases according to utility or manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.03 IDENTIFICATION

A. Identify field-installed wiring and components.

3.04 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

B. Visual and Mechanical Inspection

1. Compare equipment nameplate information with single line diagram.
2. Inspect for physical damage, cracked insulators, leaks, tightness of connections, and general mechanical and electrical conditions.
3. Verify proper auxiliary device operation.
4. Verify proper liquid level in all tanks and bushings.
5. Perform specific inspections and mechanical tests as recommended by manufacturer.
6. Verify proper equipment grounding.

7. Verify removal of any shipping bracing after final placement.

C. Electrical Tests

1. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output as shown in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistance values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
2. Perform a turns ratio test between windings at all tap positions. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
3. Insulating liquid shall be sampled in accordance with ASTM D-923. Sample shall be laboratory tested for:
    a. Dielectric breakdown voltage: ASTM D-877 or ASTM D-1816
    b. Acid neutralization number: ASTM D-974
    c. Interfacial tension: ASTM D-971 or ASTM D-2285
    d. Color: ASTM D-1500
    e. Visual Condition: ASTM D-1524
    f. Perform dissolved gas analysis (DGA) in accordance with ANSI/IEEE C57.104 or ASTM D-3612 for transformers 500 kVA and larger.
4. Perform insulation power factor tests or dissipation factor tests on all windings and bushings. Overall dielectric-loss and power factor (C_H, C_L, C_{HL}) shall be determined. Test voltages should be limited to the line to ground voltage rating of the transformer winding.
5. Perform tests and adjustments on tap-changer, fan and pump controls, and alarm function.
6. Verify proper core grounding if accessible.
7. Perform percent oxygen test on the nitrogen gas blanket for 3000 kVA or larger.

D. Test Values

1. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.
2. The polarization index should be used for future reference.
3. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.
4. Maximum power factor of liquid filled transformers corrected to 20^{o}C shall be in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.3.
5. Bushing power factors and capacitances that vary from nameplate values by more than ten percent (10%) should be investigated.
6. Dielectric fluid should comply with N.E.T.A. Acceptance Testing Specifications, Table 10.4.

E. Remove and replace malfunctioning units and retest as specified above.

F. Test Reports: Prepare written reports 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 actions taken to achieve compliance with requirements.

3.06 **FOLLOW-UP SERVICE**

A. Voltage Monitoring and Adjusting: Perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.

2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

a. Adjust transformer taps.

b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.

4. Report: Prepare written report covering monitoring and corrective actions performed.

END OF SECTION

SECTION 26 1300 - MEDIUM-VOLTAGE SWITCHGEAR

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes metal-enclosed interrupter switchgear with the following optional components, features, and accessories:

1. Copper, silver-plated main bus at connection points
2. Provisions for future devices.
3. Fungus proofing.
4. Mimic bus.

B. Related Sections:

1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.03 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. GFCI: Ground-Fault Circuit Interrupter.

1.04 **ACTION SUBMITTALS**

A. Product Data: For each type of switchgear and related equipment, include the following:

1. Rated capacities, operating characteristics, furnished specialties, and accessories for individual interrupter switches.

2. Time-current characteristic curves for overcurrent protective devices, including fusible devices.

3. Utility or manufacturer’s anchorage and base recommendations.

B. Shop Drawings: For each type of switchgear and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:

a. Tabulation of installed devices with features and ratings.

b. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.

c. Drawing of cable termination compartments showing preferred locations for conduits and indicating space available for cable terminations.

d. Floor plan drawing showing locations for anchor bolts and leveling channels.

e. Current ratings of buses.

f. Short-time and short-circuit ratings of switchgear assembly.

g. Nameplate legends.

h. Mimic-bus diagram.

i. Utility company's metering provisions with indication of approval by utility company.

2. Wiring Diagrams: For each type of switchgear and related equipment, include the following:

a. Power, signal, and control wiring.

b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.

c. Schematic control diagrams.

d. Diagrams showing connections of component devices and equipment.

e. Schematic diagrams showing connections to remote devices.

1.05 **INFORMATIONAL SUBMITTALS**

A. Source quality-control test reports.

B. Field quality-control test reports.

1.06 **QUALITY ASSURANCE**

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

D. 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.

E. Comply with IEEE C2.

1.07 **DELIVERY, STORAGE, AND HANDLING**

A. Deliver in sections of lengths that can be moved past obstructions in delivery path.

B. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.08 **PROJECT CONDITIONS**

A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:

1. Ambient temperature not exceeding 122 deg F.

B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.09 **COORDINATION**

A. Coordinate layout and installation of switchgear and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

1.10 **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: Six of each type and rating used. Include spares for future transformers, control power circuits, and fusible devices.

2. Touchup Paint: Three containers of paint matching enclosure finish, each 0.5 pint.

PART 2 PRODUCTS

2.01 **MANUFACTURED UNITS**

A. Description: Factory assembled and tested, and complying with IEEE C37.20.1.

B. Ratings: Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system.

C. System Voltage: 13.8 kV nominal; 15 kV maximum.

2.02 **METAL-ENCLOSED INTERRUPTER SWITCHGEAR**

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

1. Parkmetal (Existing Medium Voltage Switchgear is Park Metal).
2. ABB Control, Inc.
3. Eaton Corporation; Cutler-Hammer Products.
4. S&C Electric Company.
5. Siemens Industries, Inc.
6. Square D; Schneider Electric.
7. General Electric, Electrical Distribution and Control Div.
8. Continental Electrical Products

B. Comply with IEEE C37.20.3.

C. Design Level of Available-Source Fault Current: Integrated short-circuit rating consistent with value of fault current indicated.

D. Ratings: Comply with standard ratings designated in IEEE C37.20.3 for maximum-rated voltage specified.

E. Interrupter Switches: Stationary, gang operated, and suitable for application at maximum short-circuit rating of integrated switchgear assembly.

1. Rating: 600-A continuous duty and load break.
2. Duty-Cycle, Fault Closing: 40,000 asymmetrical A.
3. Switch Action: No external arc and no significant quantities of ionized gas released into the enclosure.
4. Switch Construction: Supported entirely by interior framework of structure, with copper switchblades and stored-energy operating mechanism.
5. Phase Barriers: Full length of switchblades and fuses for each pole; designed for easy removal; allow visual inspection of switch components if barrier is in place.
6. Protective Shields: Cover live components and terminals.
7. Fuses: De-energized if switch is open.

F. Mechanical Interlock: Prevent opening switch compartment door unless switchblades are open, and prevent closing switch if door is open.

G. Window: Permit viewing switchblade positions if door is closed.

H. Power Fuses: Comply with the following and with applicable requirements in NEMA SG 2:

1. Indicator: Integral with each fuse to indicate when it has blown.
2. Mounting: Positively held in position with provision for easy removal and replacement from front without special tools.
3. Expulsion Fuses: Furnished in disconnect-type mountings and renewable with replacement fuse units. Gases emitted on interruption are controlled and silenced by chambers designed for that purpose.

I. Verify utility requirements.

J. Air interrupter switches that couple to the incoming utility, meet the requirements of the local utility provider.

K. Fuse mounting insulators shall be hinged on switch assemblies directly connected to the utility primary service.

2.03 **FABRICATION**

A. Outdoor Enclosure: Galvanized steel, weatherproof construction; integral structural-steel base frame with factory-applied asphaltic undercoating.

1. Each compartment shall have the following features:

a. Structural design and anchorage adequate to resist loads imposed by 125-mph wind.

b. Space heater operating at one-half or less of rated voltage, sized to prevent condensation.

c. Louvers equipped with insect and rodent screen and filter, and arranged to permit air circulation while excluding rodents and exterior dust.

d. Hinged front door with locking provisions.

e. Power for heaters to be provided by control power transformer.

B. Enclosure Finish for Outdoor Units: Manufacturer’s standard green finish under surfaces treated with corrosion resistant undercoating.

C. Bus Transition Unit: Arranged to suit bus and adjacent units.

D. Incoming-Line Unit: Arranged to suit incoming line.

E. Outgoing Feeder Units: Arranged to suit distribution feeders.

F. Auxiliary Compartments: Arranged to suit house meters, relays, controls, and auxiliary equipment; isolated from medium-voltage components.

G. Key Interlocks: Arranged to effect interlocking schemes indicated.

H. Provisions for Future Key Interlocks: Mountings and hardware required for future installation of locks, where indicated.

2.04 **COMPONENTS**

A. Main Bus: Copper, silver plated at connection points; full length of switchgear.

B. Ground Bus: Copper, silver plated or copper, tin plated; minimum size 1/4 by 2 inches full length of switchgear.

C. Bus Insulation: Covered with flame-retardant insulation.

D. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

E. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

F. Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.

G. Control Power Supply: Control power transformer supplies 120-V control circuits through secondary disconnect devices. Include the following features:

1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.

2. Control Power Fuses: Primary and secondary fuses provide current-limiting and overload protection.

H. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:

1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2. Conductors sized according to NFPA 70 for duty required.

I. Accessories

1. Provide infrared windows at each section of gear, suitable to perform infrared readings at the lugs and bus, when energized, without opening gear to exposed live parts.

2.05 **IDENTIFICATION**

A. Materials: Refer to Division 26 Section "Electrical Identification." Identify units, devices, controls, and wiring.

B. Mimic Bus: Continuous mimic bus applied to front of switchgear, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.

1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.

2. Medium: Painted graphics, as approved.

3. Color: Contrasting with factory-finish background; selected by Architect.

2.06 **SOURCE QUALITY CONTROL**

A. Before shipment of equipment, perform the following tests and prepare test reports:

1. Production tests on circuit breakers according to ANSI C37.09.

2. Production tests on completed switchgear assembly according to IEEE C37.20.2.

B. Assemble switchgear and equipment in manufacturer's plant and perform the following:

1. Functional tests of all relays, instruments, meters, and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer secondary circuits.

2. Functional test of all control and trip circuits. Connect test devices into circuits to simulate operation of controlled remote equipment such as circuit-breaker trip coils, close coils, and auxiliary contacts. Test proper operation of relay targets.

C. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

2.07 **FACTORY FINISHES**

A. Finish: Manufacturer's standard color finish applied to equipment before shipping.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION**

A. Install switchgear and anchor to concrete bases according to utility, manufacturer's written instructions, seismic codes at project, N.E.C.A. 430-2006 and requirements in Division 26 section "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.03 **IDENTIFICATION**

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Diagram and Instructions:

1. Frame under clear acrylic plastic on front of switchgear.

a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.

b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.04 **CONNECTIONS**

A. Cable terminations at switchgear are specified in Division 26 Section "Medium-Voltage Cables."

B. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Sections "Conductors and Cables" and "Medium-Voltage Cables."

3.05 **FIELD QUALITY CONTROL**

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing."

1. Visual and Mechanical Inspection

a. Inspect for physical, electrical and mechanical condition.

b. Compare equipment nameplate information with construction document one line diagram and report discrepancies.

c. Check for proper anchorage, required area clearances, physical damage, and proper alignment.

d. Inspect all bus connections for high resistance by infrared survey after equipment has been energized.

e. Test all electrical and mechanical interlock systems for proper operation and sequencing.

1) Closure attempt shall be made on locked open devices. Opening attempt shall be made on locked closed devices.

f. Inspect accessible insulators for evidence of physical damage or contaminated surfaces.

g. Verify that fuse and/or circuit breaker sizes and types correspond to Drawings.

h. Verify proper ground connection to ground mat.

2. Electrical Tests

a. Perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground for one (1) minute.

b. Perform an over-potential test on each bus section, each phase-to-ground, for one (1) minute at values manufacturer's recommended potential.

c. Perform secondary voltage energization test on all control power circuits and potential circuits. Check voltage levels at each point on terminal boards and at each terminal on devices.

d. Control Power Transformers - Dry Type

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify proper primary and secondary fuse ratings.

3) Verify proper interlock function and contact operation.

4) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to proper secondary voltage. Check potential at all devices.

5) Verify proper secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

C. Test Values

1. Insulation resistance test to be performed in accordance with N.E.T.A. Acceptance Testing Specifications, Table 100.1. Values of insulation resistance less than manufacturer's minimum should be investigated.

2. Over-potential test voltages shall be applied in accordance with N.E.T.A. Acceptance Testing Specifications, Table 100.2. Test results are evaluated on a go, no-go basis by slowly raising the test voltage to the required value. The final test voltage shall be applied for one (1) minute.

D. Report test results in writing.

E. Remove and replace malfunctioning units and retest as specified above.

3.06 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair damaged finishes.

3.07 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.08 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 26 2200 - DRY-TYPE TRANSFORMERS (600 V AND LESS)

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 750 kVA:

1. Distribution transformers.
2. Isolation transformers.
3. Control and signal transformers.

B. Related Section includes the following:

1. Division 26 Section “Electrical General Requirements.”
2. Division 26 Section “Grounding and Bonding.”
3. Division 26 Section “Conductors and Cables.”
4. Division 26 Section “Raceways and Boxes.”
5. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.03 REFERENCES

A. ANSI/IEEE C57.12.9: Test Code for Dry-Type Distribution and Power Transformers

B. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

C. NEMA ST 1: Specialty Transformers

D. NEMA ST 20: Dry Type Transformers for General Applications

E. NEMA TP 1: Guide for Determining Energy Efficiency for Distribution Transformers

F. NEMA TP 2: Standard Test Method for Measuring the Energy Consumption of Distribution Transformers

G. NETA ATS: Acceptable Testing Specifications for Electrical Power Distribution Equipment and Systems

H. NFPA 70: National Electrical Code

I. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors

J. UL 486B: Wire Connectors for Use with Aluminum Conductors

K. UL 506: Specialty Transformers

L. UL 1561: Dry-Type General Purpose and Power Transformers

1.04 **ACTION SUBMITTALS**

A. Product Data Include rated nameplate data, capacities, weights, dimensions, utility or manufacturer’s anchorage and base recommendations, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

1. Transformer Inrush: Provide time-current coordination curves demonstrating transformer inrush and ANSI damage curves with primary overcurrent device selections to clear inrush yet still protecting damage curve.

B. Shop Drawings: Wiring and connection diagrams.

1.05 **INFORMATIONAL SUBMITTALS**

A. Source quality-control test reports. Include loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

B. Field quality control test reports

C. Output Settings Reports: Record of tap adjustments specified in Part 3.

1.06 **QUALITY ASSURANCE**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C 57.12.91.

C. Comply with NFPA 70.

D. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting doe 2016 efficiency levels when tested according to NEMA TP2.

1.07 **DELIVERY, STORAGE, AND HANDLING**

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

B. Store, protect, and handle products to site under provisions of Division 26 section “Electrical General Requirements.”

C. Deliver transformers individually wrapped for protection and mounted on shipping skids.

D. Accept transformers on site. Inspect for damage.

E. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

F. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.08 **COORDINATION**

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 "Hangers and Supports for Electrical Systems."

B. Coordinate installation of wall-mounting and structure-hanging supports.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Eaton
2. ABB
3. Siemens Industries, Inc.
4. Square D/Groupe Schneider NA.

2.02 **GENERAL TRANSFORMER REQUIREMENTS**

A. Description: Factory-assembled and tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.03 **DISTRIBUTION TRANSFORMERS**

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Grounded to enclosure.

C. Coils: Continuous windings without splices, except for taps.

1. Coil Material: Copper or Aluminum.
2. Internal Coil Connections: Brazed or pressure type.

D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.

E. Enclosures: Ventilated
   1. Core and coil must be encapsulated within resin compound to seal out moisture and air.
   2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
   3. Vibration Isolation: Isolate core and coil from enclosure using vibration-absorbing mounts.
   4. Wiring Compartment: Sized for conduit entry and wiring installation.
   5. Environmental Protection:
      a. Indoor: UL 50E, Type 2.
      b. Outdoor: UL 50E, Type 3R.
   6. Finish Color: Gray weather-resistant enamel.

F. Taps for Transformers 3 kVA and Smaller: None.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.

K. Basic Impulse Level: 10 kV.

L. Mounting: Suitable for mounting as indicated.

M. Wall Brackets: Manufacturer's standard brackets.

N. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

O. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.04 SHEILDED ISOLATION TRANSFORMERS

A. Description: Factory-assembled and –tested, air cooled, dry-type, shielded isolation transformer rated for 60 Hz operation. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. General: Comply with the requirements specified for Distribution Transformers.

C. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
   1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
   2. Include special terminal for grounding the shield.
   3. Shield Effectiveness:
      a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
      b. Common-Mode Noise Attenuation: Minus 120 dBA minimum at 0.5 to 1.5 kHz; minus 65 dBA minimum at 1.5 to 100 kHz.
      c. Normal-Mode Noise Attenuation: Minus 52 dBA minimum at 1.5 to 10 kHz.

2.05 **CONTROL AND SIGNAL TRANSFORMERS**

A. Description: Factory-assembled and tested, self-cooled, two-winding dry type, rated for continuous duty, and 60 Hz operation, complying with NEMA ST 1, and listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.06 **SOURCE QUALITY CONTROL**

A. Factory Tests and Inspections: Provide the factory tests on the actual transformers provided or on similar units identical to those provided. Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of certification of system compliance on control units.

1. Resistance measurements of windings at rated voltage connections and at tap connections.
2. Ratio tests at rated voltage connections and at tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:
    a. Line-side to ground.
    b. Load-side to ground.
    c. Line-side to load-side.
9. Temperature tests.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls and floors for suitable mounting conditions where transformers will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION**

A. Install Products in accordance with manufacturer’s instructions.

B. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

C. Install floor mounted transformers on and anchor to concrete bases according to manufacturer's recommendations.

1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

D. Identification: Engraved metal or laminated-plastic nameplate mounted with corrosion resistant screws. Provide nameplate according to Division 26 Section "Electrical Identification" indicating the following:

1. Transformer designation (e.g. "T-1").
2. Primary power characteristics (e.g. "480V, 3PH, 3W").
3. Secondary power characteristics (e.g. "208Y/120V, 3PH, 4W").
4. Power rating (e.g. "75 kVA").
5. Power source (e.g. "Fed from DP-1).

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

C. Provide conduit according to Division 26 Section "Raceways and Boxes" for connections to transformer case. Make conduit connections to side panel of enclosure.

D. 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.

E. Check for damage and tighten connections prior to energizing transformer.

3.04 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing" for transformers 75KVA and above:

1. Visual and Mechanical Inspection
   a. Inspect for physical damage, cracked insulators, tightness of connections, defective wiring and general mechanical and electrical conditions.
   b. Verify proper core grounding.
   c. Verify proper equipment grounding.
   d. Compare equipment nameplate with single line diagram and report discrepancies.
2. Electrical Tests
   a. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistance values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
   b. Perform a turns ratio test between windings at every tap position. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
   c. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
3. Test Values

a. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.

b. The polarization index should be above 1.2 unless an extremely high value is obtained initially, such that when doubled will not yield a meaningful value.

c. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.

3.05 **ADJUSTING**

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

B. Adjust buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report that records output voltages and tap settings.

END OF SECTION

SECTION 26 2413 - SWITCHBOARDS

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes service and distribution switchboards rated 600 V and less.

B. Related Sections:

1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.03 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.04 **ACTION SUBMITTALS**

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions, utility or manufacturer’s anchorage and base recommendations, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Related Submittals:

1. Provide overcurrent device coordination study to demonstrate proper overcurrent device ratings, adjustments, and settings.

C. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.

b. Bus configuration, current, and voltage ratings.

c. Short-circuit current rating of switchboards and overcurrent protective devices.

d. Descriptive documentation of optional barriers specified for electrical insulation and isolation if specified.

e. Utility company's metering provisions with indication of approval by utility company if called out.

f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

1.05 **INFORMATIONAL SUBMITTALS**

A. Field quality-control test reports including the following:

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.

1.06 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.07 **QUALITY ASSURANCE**

A. Source Limitations: Obtain switchboards through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA PB 2, "Dead-front Distribution Switchboards."

D. Comply with NFPA 70.

1.08 **DELIVERY, STORAGE, AND HANDLING**

A. Deliver in sections or lengths that can be moved past obstructions in delivery path.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.09 **PROJECT CONDITIONS.**

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

C. 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 Owner’s representative no fewer than seven days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without written permission from the Owner’s representative

1.10 **COORDINATION**

A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

1.11 **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. Potential Transformer Fuses: 2 of each size and type.

2. Control-Power Fuses: 2 of each size and type.

3. Fuses for Fused Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.

4. Indicating Lights: 3 of each size and type.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 **MANUFACTURED UNITS**

A. Manufacturers:

1. Eaton.
2. ABB
3. Siemens Industries, Inc.
4. Square D by Schneider Electric.

B. Front-Connected, Front-Accessible Switchboard:

1. Main devices over 1200A: Fixed, individually mounted.
2. Main devices below 1200A, panel mounted.
3. Branch Devices: panel-mounted.
4. Sections rear aligned.

C. Nominal System Voltage: As noted on Drawings.

D. Main-Bus Continuous: As noted on Drawings.

E. Enclosure: Steel, NEMA 250, Type 1 not over 102 in height.

F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Insulation and isolation for main and vertical buses of feeder sections.

H. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

I. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

J. Buses and Connections: Three phase, four wire, unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.

a. If bus is copper, use copper for feeder circuit-breaker line connections.

2. Ground Bus: 1/4-by-2-inch- minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3. Contact Surfaces of Buses: Silver plated.

4. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.

5. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

6. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

K. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.03 **SURGE PROTECTIVE DEVICES**

A. Direct bus connected type as specified in Division 26 Section "Surge Protective Devices."

B. Provide Surge Protective Device for switchboards that are part of the emergency distribution system.

C. Provide Surge Protective Device for switchboards elsewhere where indicated on the drawings.

2.04 **OVERCURRENT PROTECTIVE DEVICES**

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.

a. Circuit Breakers 250A and Larger: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.

2. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings with restricted access cover:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I^2t response.

3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

4. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

2. Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Shunt Trip: 120-V trip coil energized from separate circuit.

C. Fused switches rated greater than 800A: Bolted-Pressure Contact Switch.

1. Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

2. Manufacturers:

a. Boltswitch, Inc.

b. Cutler-Hammer Products; Eaton Corporation.

c. Pringle Electrical Mfg. Co.

d. Siemens Industries, Inc.

e. Square D.

3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for closing and opening.

4. Service Rated Switches: Labeled for use as service equipment.

5. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

6. Switches rated 1200A and above shall be provided with an energy-reducing maintenance switch with local status indicator and associated relays.

D. Fused Switches rated 800A and below: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

E. Fuses are specified in Division 26 Section "Fuses."

F. Circuit breaker selection for transformer primary protection:

1. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

G. Circuit breakers rated 1200A and above:

1. Circuit breakers rated 1200A and above, not specified elsewhere with zone selective interlocking, shall be provided with an energy reducing maintenance switch with local status indicator.

2.05 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

d. Megawatts: Plus or minus 2 percent.

e. Megavars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.

h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.

i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

3. Provide open protocol communication for building automation system monitoring. Preferred protocol is BACnet-MS/TP. Modbus-RTU or BACnet-IP are suitable alternatives.

2.06 CONTROL POWER

A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.07 **ACCESSORY COMPONENTS AND FEATURES**

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Provide permanent provisions for locking all overcurrent devices in switchboard. Provisions shall remain in place whether or not lock is installed.

C. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

D. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

PART 3 EXECUTION

3.01 **PROTECTION**

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.02 **EXAMINATION**

A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 **INSTALLATION**

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

B. Install switchboards and anchor to concrete bases according to utility or manufacturer’s recommendations, seismic codes at Project, and requirements in Division 26 Section “Hangers and Supports for Electrical Systems.”

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install spare-fuse cabinet.

3.04 **ADJUSTING**

A. Adjust circuit breaker trip and time delay settings to values as instructed by the Engineer.

3.05 **IDENTIFICATION**

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.06 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing.”

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Instruments, Equipment, and Reports:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2) Prepare a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 CLEANING

A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 26 2416 - PANELBOARDS

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.03 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. AFCI: Arc-fault circuit interrupter.

E. RFI: Radio-frequency interference.

F. RMS: Root mean square.

G. SPDT: Single pole, double throw.

1.04 **ACTION SUBMITTALS**

A. Product Data: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Related Submittals:

1. Provide overcurrent device coordination study to demonstrate proper overcurrent device ratings, adjustments, and settings.

C. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.

b. Bus configuration, current, and voltage ratings.

c. Short-circuit current rating of panelboards and overcurrent protective devices.

d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

1.05 **INFORMATIONAL SUBMITTALS**

A. Field quality-control test reports including the following:

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.

1.06 **CLOSEOUT SUBMITTALS**

A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

B. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.07 **QUALITY ASSURANCE**

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.08 **PROJECT CONDITIONS**

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

C. 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 Owner's representative no fewer than seven days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without written permission from Owner's representative.

1.09 **COORDINATION**

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.10 **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. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a. Eaton.

b. ABB.

c. Siemens Industries, Inc.

d. Square D by Schneider Electric

2.02 **MANUFACTURED UNITS**

A. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.

1. Rated for environmental conditions at installed location.

a. Outdoor Locations: NEMA 250, Type 3R.

b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

c. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2. Cabinet Front: Flush or surface cabinet as noted on the Drawings.

a. Eaton LTDD (Piano hinge trim)

b. ABB – FGB (front hinge to box).

c. Square D – Continuous piano hinge trim.

d. Siemens – Figure 4 hinge to box w/piano hinge.

3. Finishes:

a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: same finish as panels and trim.

4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

B. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box as called out on panel schedules.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.

2. Ground Lugs and Bus Configured Terminators: Compression type.

D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

F. Surge Protective Devices: Where indicated, provide manufactured units with direct bus connected type as specified in Division 26 Section "Surge Protective Devices."

1. Provide Surge Protective Device for all Distribution and Branch Circuit Panelboards that are part of the Emergency Distribution System.

2. Provide Surge Protective Devices elsewhere where indicated on the drawings.

2.03 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.04 DISTRIBUTION PANELBOARDS

A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

C. Main Overcurrent Protective Devices: Circuit breaker or Fused switch as indicated on drawings.

D. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

3. Fused switches.

2.05 **LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS**

A. Main bus bars, neutral and ground, shall be sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.06 **OVERCURRENT PROTECTIVE DEVICES**

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.

a. Circuit Breakers 250A and Larger: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.

2. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings with restricted access cover:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I^2t response.

3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).

5. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).

6. AFCI Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."

5. Shunt Trip: 120-V trip coil energized from separate circuit.

6. Do not use tandem circuit breakers.

7. Provide lock on devices for circuit breakers when called out on panel schedules with “LOD” designation.

8. Provide type GFEP circuit breakers for all self- regulating heating (snow melting and heat trace) cables branch circuits and where noted on panel schedules with “GFEP” designation

9. Provide GFCI circuit breaker when called out on panel schedules with “GFCI” designation.
10. Provide Arc-Fault Circuit Interrupters where indicated on panel schedule with “AFCI” designation.
11. Provide shunt trip breakers when called out on panel schedules with “STB” designation.
12. Provide smart controllable circuit breakers when called out on panel schedules with “SMT” designation.
13. Provide permanent padlockable handle for circuit breakers when called out on panel schedules with “PL” designation.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Division 26 Section "Fuses."

E. Circuit Breaker Selection for Transformer Primary Protection:

1. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

2.07 **ACCESSORY COMPONENTS AND FEATURES**

A. Provide permanent provisions for padlocking all overcurrent devices in Distribution Panelboards. Provisions shall remain in place whether or not lock is installed.

B. Provide permanent provisions for padlocking overcurrent devices in Branch Circuit Panelboards that serve equipment not provided with a local, lockable disconnecting means. Provisions shall remain in place whether or not lock is installed

PART 3 EXECUTION

3.01 **INSTALLATION**

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section “Hangers and Supports for Electrical Systems.”

C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.02 **IDENTIFICATION**

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads or created by retrofitting. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Coordinate final directory room names and numbers with Owner’s representative.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.03 **CONNECTIONS**

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.04 **FIELD QUALITY CONTROL**

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Perform electrical tests on all breakers and switches 200A and above or that constitute a component of an emergency distribution system. Main circuit breakers in branch circuit panelboards 225A and below are not required to be tested.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 **CLEANING**

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 2713 - ELECTRICITY METERING

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes equipment for electricity metering by Owner.

1.03 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual. Include the following:

1. Electricity-metering equipment.

B. Shop Drawings for Electricity-Metering Equipment:

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electricity-metering equipment to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center as specified in NECA 400.

1.08 **COORDINATION**

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power and communication services.

2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 PRODUCTS

2.01 **EQUIPMENT FOR ELECTRICITY METERING BY OWNER**

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

1. Honeywell E-Mon Multi Mon (Basis of design)

2. Electro Industries Gauge Tech (Shark)

B. In addition to requirements indicated below metering to provide compliance with current ASHRAE 90.1 version adopted by Michigan electrical energy monitoring requirements.

C. Kilowatt-Hour Meter: Electronic single- and three-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.

2. Display: Digital liquid crystal, indicating accumulative kilowatt hours and current kilowatt load.

D. Kilowatt-Hour/Demand Meter: Electronic single- and three-phase meters, measuring electricity use and demand.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.

2. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.

E. Provide open protocol communication for building automation system monitoring. Preferred protocol is BACnet-MS/TP. Modbus-RTU or BACnet-IP are suitable alternatives.

F. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.

G. Identification: Comply with Division 26 Section "Electrical Identification."

H. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.

I. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.

a. Type: Split core.

J. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.

K. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

PART 3 EXECUTION

3.01 **INSTALLATION**

A. Comply with equipment installation requirements in NECA 1.

B. Install modular meter center according to NECA 400 switchboard installation requirements.

3.02 **FIELD QUALITY CONTROL**

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing.”

B. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.

2. Turn off circuits supplied by metered feeder and secure them in off condition.

3. Run test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.

4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.

5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

END OF SECTION

SECTION 26 2726 - WIRING DEVICES

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Single and duplex receptacles
2. Ground-fault circuit interrupter receptacles
3. Controlled receptacles.
4. Single- and double-pole snap switches.
5. Device wall plates.
6. Pin and sleeve connectors and receptacles.

1.03 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. AFCI: Arc-fault circuit interrupter.

D. PVC: Polyvinyl chloride.

E. RFI: Radio-frequency interference.

F. SPD: Surge protective devices.

G. UTP: Unshielded twisted pair.

H. USB: Universal serial bus.

1.04 **REFERENCES**

A. DSCC W-C-596G: Federal Specification Connector, Electrical, Power, General Specification.

B. DSCC W-C-896F: Federal Specification Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

C. IEC 309-1, Part 1: General Requirements: Plugs, Socket-Outlets and Couplers for Industrial Purposes

D. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.

E. NEMA WD 1: General Requirements for Wiring Devices.

F. NEMA WD 6: Wiring Device – Dimensional Requirements.

G. UL 20: General-Use Snap Switches.

H. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

I. UL 486B: Wire Connectors for Use with Aluminum Conductors.

J. UL 498: Electrical Attachment Plugs and Receptacles.

K. UL 943: Ground Fault Circuit Interrupters.

L. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.05 **ACTION SUBMITTALS**

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations for each type of product indicated.

1.06 **INFORMATIONAL SUBMITTALS**

A. Field quality control test reports

1.07 **QUALITY ASSURANCE**

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.08 **COORDINATION**

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.01 **GENERAL WIRING DEVICE REQUIREMENTS**

A. Comply with NFPA 70, NEMA WD 1, NEMA WD 6, and UL498.

B. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.

2. Cord and Plug Sets: Match equipment requirements.

C. Device Color:

1. Wiring Devices Connected to Normal Power System not controlled receptacle: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Normal Power System controlled receptacle: Gray, unless otherwise indicated or required by NFPA 70 or device listing.

3. Wiring Devices Connected to Emergency Power System: Red.

4. Wiring Devices Connected to Optional Standby Power System: Red.

5. Wall Switches: Ivory, unless otherwise indicated.

2.02 STANDARD GRADE RECEPTACLES

A. Duplex Receptacle, NEMA 5-20R:

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

B. Tamper-Resistant Duplex Receptacle, NEMA 5-20R:

1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.

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

a. Hubbell Wiring Device-Kellems: 5362TR

b. Eaton/Arrow Hart Wiring Devices: AHTR5362

c. Leviton: 5362-SG

d. Legrand, Pass & Seymour: TR5362

C. Weather- and Tamper-Resistant Duplex Receptacle, NEMA 5-20R:

1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.

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

a. Hubbell Wire Device-Kellems: BR20WRTR

b. Eaton/Arrow Hart Wiring Devices: TWRBR20

c. Leviton: TWR20

d. Legrand, Pass & Seymour: WR5352TR

2.03 GFCI RECEPTACLES

A. General:

1. Comply with UL 943

B. Tamper-Resistant Duplex GFCI Receptacle, NEMA 5-20R:

1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide one of the following:
   a. Hubbell Wiring Device-Kellems: GFTRST20
   b. Eaton/Arrow Hart Wiring Devices: TRSGF20
   c. Leviton: GFTR2
   d. Legrand, Pass & Seymour: 2097TR

C. Tamper- and Weather-Resistant Duplex GFCI Receptacle, NEMA 5-20R:
1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide one of the following:
   a. Hubbell Wiring Device-Kellems: GFTWRST20
   b. Eaton/Arrow Hart Wiring Devices: TWRSGF20
   c. Leviton: GFWT2
   d. Legrand, Pass & Seymour: 2097TRWR

D. Dead Front GFCI, 20A:
1. Manufacturers: Subject to compliance with requirements, provide one of the following:
   a. Hubbell Wiring Device-Kellems: GFBFST20
   b. Eaton/Arrow Hart Wiring Devices: SGF20
   c. Leviton: GFRBF
   d. Legrand, Pass & Seymour: 2087.

2.04 CONTROLLED RECEPTACLES

A. General:
1. Comply with NEC Article 406.3(E). Provide permanent markings of controlled symbol and the word “controlled”.

B. Controlled Tamper-Resistant Duplex Receptacle, NEMA 5-20R:
1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell Wiring Device-Kellems: HBL5362__TR
   b. Eaton/Arrow Hart Wiring Devices: Equal to Hubbell
   c. Leviton: Equal to Hubbell
   d. Legrand, Pass & Seymour: Equal to Hubbell

C. Controlled Tamper-Resistant Duplex GFCI Receptacle, NEMA 5-20R:
1. Safety mechanism to energize contacts only when both openings are simultaneously engaged.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Hubbell Wiring Device-Kellems: GFRTR20C2
    b. Eaton/Arrow Hart Wiring Devices: Equal to Hubbell
    c. Leviton: Equal to Hubbell
    d. Legrand, Pass & Seymour: Equal to Hubbell

2.05 STRAIGHT BLADE AND TWIST-LOCK RECEPTACLES, OTHER THAN NEMA 5-20R

A. Provide commercial specification grade straight blade and twist-lock receptacles with standard NEMA configurations in accordance with the “Special Receptacles” schedule included on the drawings.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Hubbell Wiring Device-Kellems
    2. Eaton/Arrow Hart Wiring Devices
    3. Leviton
    4. Legrand, Pass & Seymour

2.06 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking type plug and receptacle body connector, NEMA WD 6, device configurations as indicated on drawings, heavy-duty grade.

B. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

C. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.07 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.08 WALL SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    1. Hubbell Wiring Device-Kellems: 1220 Series
    2. Eaton/Arrow Hart Wiring Devices: AH1220 Series
    3. Leviton: 1220 Series
    4. Legrand, Pass & Seymour: PS20AC Series

B. Device body: Plastic handle.

C. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.

D. Snap Switches: Heavy Duty specification grade, quiet type; rated 20A., 120-277 V AC.

E. Provide single-pole, two-pole, three-way and four-way switches as indicated.

F. Provide pilot light where indicated. Switch shall be illuminated when the switch is on.

G. Provide key type where indicated. Furnish four keys to Owner.

H. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.

1. Switch: 20 A, 120/277-V ac.

2. Receptacle: NEMA WD 6, Configuration 5-20R.

2.09 WALL PLATES

A. Manufacturers:

1. Provide wall plates and corresponding wiring devices from same manufacturer.

B. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces:

a. Smooth, high-impact thermoplastic, color to match wring device.

3. Material for Unfinished Spaces:

a. Smooth, high-impact thermoplastic, color to match wiring device.

4. Material for Wet Locations: Gasketed Cast aluminum with hinged cover and listed and labeled as Extra Duty Weatherproof While-In-Use.

a. Manufacturers:

1) Hubbell: MX3200

2) Red Dot Model: CKLSVU, Thomas & Betts

3) Intermatic: WP3110MXD

4) Leviton: IUM1V

5. Material for Damp Locations: Gasketed Cast aluminum with hinged cover and listed and labeled as Weatherproof.

a. Manufacturers:

1) Red Dot Model CCGV, ABB Installation Products

2) Eaton/Arrow Hart WLRD1

3) Legrand, Pass & Seymour

4) Intermatic: WP3110MXD

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.

C. Install devices and assemblies level, plumb, and square with building lines.

D. Arrangement of Devices:

1. Coordinate locations of outlet boxes provided under Division 26 Section “Raceways and Boxes” to obtain mounting heights indicated on Drawings.

2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.

3. Where multiple receptacles, switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.

4. Install horizontally mounted receptacles with grounding pole on the left.

5. Install GFCI receptacles so that the “Push To Test” and “Reset” designations can be read correctly. If printed in both directions, install with ground pole on top.

6. Install switches with OFF position down.

E. Install cover plates on switch, receptacle, and blank outlets in finished areas.

F. Install weather-resistant type receptacles in all damp and wet locations, including pool environments.

G. Install weatherproof cover plates on receptacles in damp locations.

H. Install weatherproof While-In-Use cover plates on receptacles in wet locations.

I. Install tamper-resistant type receptacles in all locations as required by the NEC (406.12) and as indicated on plan.

J. Use oversized plates for outlets installed in masonry walls.

K. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

L. Remove wall plates and protect devices and assemblies during painting.

M. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

N. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.

3.02 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on face of wall plate, and durable wire markers or tags inside outlet boxes.

2. Wall Switches: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on back side of wall plate, and durable wire markers or tags inside outlet boxes.

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding." Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.

B. Connect wiring according to Division 26 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.

C. 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.

3.04 **FIELD QUALITY CONTROL**

A. Perform the following field tests and inspections and prepare test reports:

1. Inspect each wiring device for defects.
2. Operate each wall switch with circuit energized and verify proper operation.
3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION

SECTION 26 2813 - FUSES

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Cartridge fuses rated 600 V and less for use in switches, panelboards, switchboards, and controllers.

1.03 ACTION SUBMITTALS

A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.
4. Fuse size for elevator feeders and elevator disconnect switches.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
   a. Let-through current curves for fuses with current-limiting characteristics.
   b. Time-current curves, coordination charts and tables, and related data.
   c. Ambient temperature adjustment information.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with:

1. NEMA FU 1 – Low Voltage Cartridge Fuses.
2. NFPA 70 – National Electrical Code.
3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
4. UL 198E – Class R Fuses.
5. UL 512 – Fuseholders.

1.06 **PROJECT CONDITIONS**

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.07 **COORDINATION**

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

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. Fuses: Quantity equal to 10% percent of each fuse type and size, but no fewer than 3 of each type and size.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Cooper Bussmann, Inc.
2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
3. Ferraz Shawmut, Inc.
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.02 **CARTRIDGE FUSES**

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

1. Service Entrance: Class T, fast acting.
2. Feeders: Class RK1, time delay.
3. Motor Branch Circuits: Class RK5, time delay.
4. Other Branch Circuits: Class RK1, time delay.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **INSTALLATION**

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energization at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energization of the circuit in which it is applied.

B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.03 **IDENTIFICATION**

A. Install labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION

SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 26 Section “Fuses”.
2. Division 26 Section “Hangers and Supports for Electrical Systems”.

1.02 SUMMARY

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Fusible switches.
2. Non-fusible switches.
3. Molded-case circuit breakers.
4. Molded-case switches.
5. Enclosures.

1.03 DEFINITIONS

A. GD: General duty.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault circuit-interrupter for equipment protection.

D. GFLS: Ground-fault circuit-interrupter for life safety.

E. HD: Heavy duty.

F. RMS: Root mean square.

G. SPDT: Single pole, double throw.

1.04 **REFERENCES**

A. NECA 1: Practices for Good Workmanship in Electrical Contracting.

B. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

C. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches.

E. NEMA FU 1: Low Voltage Cartridge Fuses.

F. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

G. NEMA PB1.1: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

H. NEMA PB2.1: General Instructions for Proper Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

I. NFPA 70: National Electrical Code.

J. UL 50: Enclosures for Electrical Equipment, Non-Environmental Considerations.

K. UL 50E: Enclosures for Electrical Equipment, Environmental Considerations

L. UL 98: Enclosed and Dead-Front Switches

M. UL 489: Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

N. UL 1053: Standard For Ground-Fault Sensing and Relaying Equipment.

O. UL 1077: Supplementary Protectors for Use in Electrical Equipment

P. UL 508: Industrial Control Equipment

1.05 **ACTION SUBMITTALS**

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

2. Enclosure types and details for types other than UL 50E, Type 1.

3. Current and voltage ratings.

4. Short-circuit current rating.

5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.06 **INFORMATIONAL SUBMITTALS**

A. Field quality-control test reports including the following:

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.

1.07 **CLOSEOUT SUBMITTALS**

A. 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 1 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.08 **MAINTENANCE MATERIAL SUBMITTALS**

A. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

B. Fuse Pullers: Two for each size and type.

PART 2 PRODUCTS

2.01 **GENERAL REQUIREMENTS**

A. Source Limitations: Obtain products from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2.02 **FUSIBLE SWITCHES**

A. Manufacturers:

1. Eaton.
2. ABB.
3. Siemens Industries, Inc.
4. Square D by Schneider Electric.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 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. 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. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Service-Rated Switches: Labeled for use as service equipment.

5. Hook stick Handle: Allows use of hook stick to operate handle.
6. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120 V(ac).
    a. Provide auxiliary contacts for fusible switches serving Elevators.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 **NONFUSIBLE SWITCHES**

A. Manufacturers:
1. Eaton.
2. ABB.
3. Siemens Industries, Inc.
4. Square D by Schneider Electric.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 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, Three Pole, Double Throw, 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.

D. 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. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating – 120VAC.
    a. Provide auxiliary contacts for motor disconnects served by variable frequency controllers.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.04 **MOLDED-CASE CIRCUIT BREAKERS**

A. Manufacturers:
1. Eaton.
2. ABB.
3. Siemens Industries, Inc.
4. Square D by Schneider Electric.

B. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.

C. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.

D. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker.

E. MCCBs must be equipped with device for locking in isolated position.

F. Lugs must be suitable for 90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70.

G. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits.

1. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. 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 I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).

M. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).

N. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Application Listing: Appropriate for application.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
5. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

2.05 MOLDED-CASE SWITCHES

A. Manufacturers:

1. Eaton.
2. ABB.
3. Siemens Industries, Inc.
4. Square D by Schneider Electric.

B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

D. Features and Accessories:

1. Standard frame sizes and number of poles.

2. Lugs:
   a. Mechanical type, suitable for number, size, trip ratings, and conductor material.
   b. Lugs must be suitable for 90 deg C rated wire, sized in accordance with 75 deg C temperature rating in NFPA 70.
3. Key Interlock Kit: Externally mounted to prohibit switch operation; key must be removable only when switch is in off position.

2.06 **ENCLOSURES**

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish:
1. Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1)
2. Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (UL 50E Types 3R, 12)
3. A brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel)

C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts.

D. Operating Mechanism:
1. Directly operable through front cover of enclosure (UL 50E Type 1).
2. Directly operable through dead front trim of enclosure (UL 50E Type 3R).
3. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.

2.07 **TOGGLE DISCONNECT SWITCH**

A. Manufacturers:
1. Double Pole:
   a. Hubbell 1372.
   b. Leviton 3032-2W.
   c. Pass & Seymour 7812.
   d. Bryant 30102.
2. Three Pole:
   a. Hubbell 1379.
   b. Leviton MS303-DSW.
   c. Pass & Seymour 7813.
   d. Bryant 30103.

B. Description: Heavy duty, 30A, 600 volts, double or three pole as required, single throw, motor rated switch without overload protection. Provide NEMA 1 enclosure and padlock attachment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 1.

B. Outdoor Locations: UL 50E, Type 3R.

C. Kitchen and Wash-Down Areas: UL 50E, Type 4X, stainless steel.

D. Other Wet or Damp, Indoor Locations: UL 50E, Type 4.

E. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.03 INSTALLATION

A. Comply with manufacturer’s published instructions.

B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

3. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

4. Install fuses in fusible devices.

C. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

D. Anchor floor-mounted switches to concrete base.

E. Install NEMA KS 1 enclosed switch for motor loads ½ HP and larger and equipment loads greater than 30A.

F. Install toggle disconnect switch, surface mounted, for motor loads less than ½ HP and equipment loads 30A. and less.

G. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.

H. Install equipment on exterior foundation walls at least one inch from wall to permit vertical flow of air behind breaker and switch enclosures.

I. Support enclosures independent of connecting conduit or raceway system.

J. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.04 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Electrical Identification.”

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.
3. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

3.05 **FIELD QUALITY CONTROL**

A. Prepare for acceptance testing as follows:
1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.

B. Perform field quality control tests in accordance with Division 26 section “Electrical Testing”:

C. Tests and Inspections for Switches:
1. Visual and Mechanical Inspection:
a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the following methods:
1) Use low-resistance ohmmeter.
a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Measure contact resistance across each switchblade fuse holder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

D. Tests and Inspections for Molded-Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify that unit is clean.

e. Operate circuit breaker to ensure smooth operation.

f. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.

h. Perform adjustments for final protective device settings in accordance with coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 M Ω.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.

f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.

g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.

h. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Test and adjust controls, remote monitoring, and safeties.

E. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

2. Remove and replace defective units and retest.

F. Collect, assemble, and submit test and inspection reports.

1. Test procedures used.

2. Include identification of each enclosed switch and circuit breaker tested and describe test results.

3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.06 **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 in accordance with study report specified in Division 26 Section “Overcurrent Device Coordination Study/Arc Flash Hazard Analysis”.

3.07 **PROTECTION**

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.08 **MAINTENANCE**

A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

3.09 **ADJUSTING**

A. Set field-adjustable switches and circuit-breaker trip and time delay settings to values as determined by the protective device coordination study.

3.10 **CLEANING**

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION

SECTION 26 2913 - ENCLOSED CONTROLLERS

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.
2. Reduced-voltage controllers.

B. Related Sections include the following:

1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
2. Division 20 Section "Variable Frequency Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.
3. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.03 **ACTION SUBMITTALS**

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

1.04 **INFORMATIONAL SUBMITTALS**

A. Shop Drawings: For each enclosed controller.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.

b. Nameplate legends.

c. Short-circuit current rating of integrated unit.

d. UL listing for series rating of overcurrent protective devices in combination controllers.

e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring.

B. Field quality-control test reports.

1.05 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

B. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.06 **REFERENCES**

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current-Limiting Types.

C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.

D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses).

E. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.

F. NECA 402-2000 – Recommended Practice for Installing and Maintaining Motor Control Centers.

G. NEMA AB 1 - Molded Case Circuit Breakers.

H. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

I. NEMA KS 1 - Enclosed Switches.

J. ANSI/NFPA 70 - National Electrical Code.

1.07 **QUALITY ASSURANCE**

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

1.08 **DELIVERY, STORAGE, AND HANDLING**

A. Prior to beginning work on any system, verify all existing conditions that affect the work and coordinate with all other trade Contractors. Determine that the work can be installed as indicated or immediately report to the Architect/Engineer errors, inconsistencies or ambiguities.

B. Deliver products to site under provisions of Section 26 0010. Store and protect products under provisions of Section 26 0010.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift large equipment only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

E. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.09 **PROJECT RECORD DOCUMENTS**

A. Accurately record actual locations of each contactor and indicate circuits controlled. Submit under provisions of 26 0010.

1.10 **PROJECT CONDITIONS**

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner’s representative no fewer than seven days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without written permission from Owner’s representative.

1.11 **COORDINATION**

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.12 **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. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.

2. Indicating Lights: Two of each type installed.

3. Keys: Furnish 2 of each to Owner.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. ABB.

2. Eaton .

3. Siemens

4. Square D by Schneider Electric

2.02 **ACROSS-THE-LINE ENCLOSED CONTROLLERS**

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, non-fusible switch.

3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.03 **VARIABLE FREQUENCY CONTROLLERS**

A. Refer to Division 20 section “Variable Frequency Controllers.”

B. Equipment furnished by mechanical trades and installed by electrical trades.

2.04 **ENCLOSURES**

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.05 **ACCESSORIES**

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights: NEMA ICS 2, heavy-duty type.

C. Indicating Lights: Run (Red), off or ready (Green).

D. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) contacts.

E. Selector Switch: NEMA ISC 2, mounted in front cover to read “hand/off/auto,” provide auxiliary contact for auto position monitoring.

F. Control Relays: Auxiliary and adjustable time-delay relays.

G. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

H. Current-Sensing, Phase-Failure Relays for Bypass Controllers: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

I. Manufacturer provided nameplate shall be provided on controller enclosure. Nameplate shall contain the following information:

1. Manufacturer’s name or identification.
2. Voltage rating.
3. Current and/or horsepower rating.
4. Short-circuit current rating,

2.06 **FACTORY FINISHES**

A. Enclosure Finish: The enclosure shall be: gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1). Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12). Brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel).

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 **APPLICATIONS**

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.03 **INSTALLATION**

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install freestanding equipment on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

E. Install motor control equipment and contactors in accordance with manufacturer’s instructions.

F. Select and install heater elements in motor starters to match installed motor characteristics.

G. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.04 **CONCRETE BASES**

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

3.05 **IDENTIFICATION**

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Electrical Identification."

3.06 **CONTROL WIRING INSTALLATION**

A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.07 **CONNECTIONS**

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.08 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters and Motor Control - Adjustable Speed Drive Systems." Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.09 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION

SECTION 26 3323 - CENTRAL BATTERY INVERTERS

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements.”

1.02 SUMMARY

A. This Section includes fast-transfer central battery inverters with the following features:

1. Output distribution section.
2. Internal maintenance bypass/isolation switch.
3. Remote monitoring provisions.

B. Related Sections:

1. Division 26 “Hangers and Supports for Electrical Systems” for concrete bases.

1.03 **DEFINITIONS**

A. LCD: Liquid-crystal display.

B. LED: Light-emitting diode.

C. UPS: Uninterruptible power supply.

1.04 **ACTION SUBMITTALS**

A. Product Data: For the following:

1. Electrical ratings, including the following:
   a. Capacity to provide power during failure of normal ac.
   b. Inverter voltage regulation and total harmonic distortion of output current.
   c. Rectifier data.
   d. Transfer time of transfer switch.
   e. Data for specified optional features.
2. Transfer switch.
3. Inverter.
4. Battery charger.
5. Batteries.
6. Battery monitoring.
7. Manufacturer’s anchorage and base recommendations.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.

1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
2. Elevation and details of control and indication displays.
3. Output distribution section.

1.05 **INFORMATIONAL SUBMITTALS**

A. Source quality-control test reports.

B. Field quality-control test reports.

1.06 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For central battery inverter equipment to include in emergency, operation, and maintenance manuals specified in Division 1.

B. Warranties: Special warranties specified in this Section.

1.07 **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. Central Battery Inverter System: UL 924 listed.

C. Comply with NFPA 70 and NFPA 101.

1.08 **DELIVERY, STORAGE, AND HANDLING**

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for nonoperating equipment.

1.09 **WARRANTY**

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

B. Warranty Period: Include the following warranty periods, from date of Substantial Completion.

1. Standard, Valve-Regulated, Recombinant, Lead-Calcium Batteries:

a. Full Warranty: One year.

b. Pro Rata: Nine years.

1.10 **COORDINATION**

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 “Hangers and Supports for Electrical Systems.”

1.11 **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. Deliver extra materials to Owner.

1. Fuses: One for every 10 of each type and rating, but no fewer than 3 of each.

2. Cabinet Ventilation Filters: One complete set.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Myers Power Products, Inc. (Basis of design)

2. Chloride Systems.

3. Controlled Power Company.

4. Cooper Industries, Inc.; Sure-Lites Division.

5. Dual-Lite.

6. Lithonia Lighting; Emergency Lighting Systems.

7. Thomas & Betts Corporation; Emergi-Lite Corporation Division.

2.02 **INVERTER PERFORMANCE REQUIREMENTS**

A. Ratings: Provide rated KVA output, input voltage and output voltage as indicated on the drawings.

B. Fast-Transfer Central Battery Inverters: Automatically sense loss of normal ac supply and use a solid-state switch to transfer loads. Transfer in 0.004 second or less from normal supply to battery-inverter supply.

1. Operation: Unit supplies power to output circuits from a single, external, normal supply source. Unit automatically transfers load from normal source to internal battery/inverter source. Retransfer to normal is automatic when normal power is restored.

C. Maximum Acoustical Noise: 50 dB, "A" weighting, emanating from any component under any condition of normal operation, measured 39 inches from nearest surface of component enclosure.

2.03 SERVICE CONDITIONS

A. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Ambient Temperature for Electronic Components: 32 to 98 deg F.
2. Relative Humidity: 0 to 95 percent, noncondensing.
3. Altitude: Sea level to 4000 feet.

2.04 INVERTERS

A. Description: Solid-state type, with the following operational features:

1. Automatically regulate output voltage to within plus or minus 5 percent.
2. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
3. Output Voltage Waveform of Unit: Sine wave with maximum 10 percent THD throughout battery operating-voltage range, from no load to full load.
    a. THD may not exceed 5 percent when serving a resistive load of 100 percent of unit rating.
4. Output power rating: Rated in kVA at unity power factor, and shall be able to supply the rated kW from .5 lagging to .5 leading.
5. Output Protection: Current-limiting and short-circuit protection.
6. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

2.05 BATTERY CHARGER

A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

2.06 BATTERIES

A. Description: Standard, valve-regulated, recombinant, lead-calcium batteries.

2.07 ENCLOSURES

A. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.

B. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.08 CONTROL AND INDICATION

A. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.

B. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.

C. Indications: Labeled LED or Plain-language messages on a digital LCD or LED.

1. Quantitative Indications:
    a. Input voltage, each phase, line to line.
    b. Input current, each phase, line to line.
    c. System output voltage, each phase, line to line.
    d. System output current, each phase.
    e. System output frequency.
    f. DC bus voltage.
    g. Battery current and direction (charge/discharge).
    h. Elapsed time-discharging battery.
2. Basic Status Condition Indications:
    a. Normal operation.
    b. Load-on bypass.
    c. Load-on battery.
    d. Inverter off.
    e. Alarm condition exists.
3. Alarm Indications:
    a. Battery system alarm.
    b. Control power failure.
    c. Fan failure.
    d. Overload.
    e. Battery-charging control faulty.
    f. Input overvoltage or undervoltage.
    g. Approaching end of battery operation.
    h. Battery undervoltage shutdown.
    i. Inverter fuse blown.
    j. Inverter transformer overtemperature.
    k. Inverter overtemperature.
    l. Static bypass transfer switch overtemperature.
    m. Inverter power supply fault.
    n. Inverter output overvoltage or undervoltage.
    o. System overload shutdown.
    p. Inverter output contactor open.
    q. Inverter current limit.
4. Controls:
    a. Inverter on-off.
    b. Start.
    c. Battery test.
    d. Alarm silence/reset.

e. Output-voltage adjustment.

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:

1. Inverter on battery.
2. Inverter on-line.
3. Inverter load-on bypass.
4. Inverter in alarm condition.
5. Inverter off (maintenance bypass closed).

E. Include the following minimum array:

1. Ready, normal-power on light.
2. Charge light.
3. Inverter supply load light.
4. Battery voltmeter.
5. AC output voltmeter with an accuracy within 2 percent of full scale.
6. Load ammeter.
7. Test switch to simulate ac failure.

F. Enclosure: Steel, with hinged lockable doors, suitable for wall or floor mounting. Manufacturer's standard corrosion-resistant finish.

2.09 OPTIONAL FEATURES

A. Multiple Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.

B. Maintenance Bypass/Isolation Switch: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in bypass mode. Switch provides manual selection among the following three conditions without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing central battery inverter system. Normal ac input circuit, static bypass transfer switch, and central battery inverter load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing central battery inverter system. Central battery inverter ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal central battery inverter ac supply terminals are energized and the load is supplied through either static bypass transfer switch and central battery inverter rectifier-charger and inverter, or battery and inverter.

2.10 OUTPUT DISTRIBUTION SECTION

A. Panelboard: Comply with Division 26 Section "Panelboards," except provide assembly integral to equipment cabinet.

2.11 SYSTEM MONITORING AND ALARMS

A. Provisions for Remote Computer Monitoring: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in Part 2 "Control and Indication" Article. Remote computer and connecting signal wiring will be provided by Owner. Include the following features:

1. Connectors and network interface units or modems for data transmission via RS-232 link.

B. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

1. Annunciation of Alarms: At inverter system control panel.

2.12 **SOURCE QUALITY CONTROL**

A. Factory test complete inverter system, including battery, before shipment. Include the following:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide access for Owner's representative to observe tests at Owner's option.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 EXECUTION

3.01 **EXAMINATION**

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be 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.

3.02 **INSTALLATION**

A. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.03 **CONNECTION**

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."

C. 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.

3.04 **IDENTIFICATION**

A. Identify equipment and components according to Division 26 Section “Electrical Identification.”

3.05 **FIELD QUALITY CONTROL**

A. After central battery inverters are installed and electrical circuitry has been energized, test for compliance with requirements.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing” and according to manufacturer's written instructions and as listed below, to demonstrate condition and performance of each component of central battery inverter system:

1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.
4. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.18 and 7.22.2. Certify compliance with test parameters.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including electrical connections. Report results in writing.

D. Remove malfunctioning units, replace with new units, and retest as specified above.

E. Report results in writing.

3.06 **STARTUP SERVICE**

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that central battery inverter is installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.07 **ADJUSTING AND CLEANING**

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

3.08 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters. Refer to Division 1 Section "Closeout Procedures/Demonstration and Training."

END OF SECTION

SECTION 26 4313 - SURGE PROTECTIVE DEVICES

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes:

1. Type 2 surge protective devices.
2. Enclosures

B. Related Sections include the following:

1. Division 26 Section "Switchboards" for integral Type 2 SPDs installed by switchboard manufacturer.
2. Division 26 Section "Panelboards" for integral Type 2 SPDs installed by panelboard manufacturer.

1.03 DEFINITIONS

A. I_n: Nominal discharge current.

B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.

C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.

D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient over-voltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).

E. SCCR: Short-circuit current rating.

F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

H. Type 3 SPDs: Point of utilization SPDs.

I. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.04 **ACTION SUBMITTALS**

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

1. For each type of product.

a. Include electrical characteristics, specialties, and accessories for SPDs.

b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:

1) Tested values for VPRs.

2) I_n ratings.

3) MCOV, type designations.

4) OCPD requirements.

5) Manufacturer's model number.

6) System voltage.

7) Modes of protection.

1.05 **INFORMATIONAL SUBMITTALS**

A. Field quality-control reports.

1.06 **CLOSEOUT SUBMITTALS**

A. Warranty: For manufacturer's special warranty.

1.07 **WARRANTY**

A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.

PART 2 PRODUCTS

2.01 **TYPE 2 SURGE PROTECTIVE DEVICE (SPDS)**

A. Manufacturers:

1. Cutler-Hammer, Inc.; Eaton Corporation.

2. General Electric Company.

3. Siemens Industries, Inc.

4. Square D; Schneider Electric.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. General Characteristics:

1. Reference Standards: UL 1449 (latest Edition), Type 2; UL 1283 (latest edition).

2. EMI-RFI Noise Rejection: based on MIL-STD-E220A, 50-ohm standard Insertion Loss Test:

a. 34dB at 100 kHz.

b. 51dB at 1 MHz.

c. 54dB at 10 MHz.

d. 48dB at 100 MHz.

3. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.

4. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than:

   a. Service Entrance Switchboard: 320kA

   b. Distribution panelboards and switchboards 800A or greater: 150KA

   c. Distribution Panelboards and Branch Circuit Panelboards 600A and less: 100kA

5. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

6. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits must not exceed the following:

   a. Line to Neutral: 1200 V

   b. Line to Ground: 1200 V

   c. Neutral to Ground: 1200 V

   d. Line to Line: 2000 V

7. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits must not exceed the following:

   a. Line to Neutral: 700 V.

   b. Line to Ground: 700 V.

   c. Neutral to Ground: 700 V.

   d. Line to Line: 1200 V.

8. SCCR: Equal or exceed 200 kA.

9. I_n Rating: 10 kA.

D. Options:

1. Include LED indicator lights for power and protection status.

2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.

3. Include surge counter.

2.02 ENCLOSURES

A. Indoor Enclosures: Type 1.

B. Outdoor Enclosures: Type 3R.

PART 3 EXECUTION

3.01 INSTALLATION

A. Surge protective devices shall be factory installed in all new distribution equipment.

B. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.

C. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
2. Do not exceed manufacturer's recommended lead length.
3. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.02 **FIELD QUALITY CONTROL**

A. Tests and Inspections:

1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's installation requirements.

B. Nonconforming Work:

1. SPDs that do not pass tests and inspections will be considered defective.
2. Remove and replace defective units and retest.

C. Prepare test and inspection reports.

D. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.03 **STARTUP SERVICE**

A. Complete startup checks in accordance with manufacturer's instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION

SECTION 26 5119 - LED INTERIOR LIGHTING

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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. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Division 26 "Lighting Control Devices."

1.03 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lamp: LED and substrate as a replaceable assembly.

F. LED: Light-emitting diode.

G. Lumen: Measured output of lamp and luminaire, or both.

H. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.04 **ACTION SUBMITTALS**

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.

2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaires.

4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.

6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project per IES LM-79 and IES LM-80.

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products or certified by a qualified independent testing agency.

1.05 **INFORMATIONAL SUBMITTALS.**

A. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Sample warranty.

1.06 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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. Lamps: 5% attic stock of each type and rating installed. Furnish at least one of each type.

2. LED Drivers 5% attic stock of each type and rating installed. Furnish at least one of each type.

3. Diffusers and Lenses: 1% attic stock of each type and rating installed. Furnish at least one of each type.

4. Globes and Guards: 5% attic stock of each type and rating installed. Furnish at least one of each type.

1.08 **QUALITY ASSURANCE**

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. 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.

E. Comply with:

1. NFPA 70 - National Electrical Code.
2. NECA/IESNA 500-1998 – Recommended Practice for Installing Indoor Commercial Lighting Systems.
3. NECA/IESNA 502-1999 – Recommended Practice for Installing Industrial Lighting Systems.
4. Code of Federal Regulations (47 CFR 37342).
5. Michigan Department of Community Industry Services requirements that all lamps shall be protected from breakage. Exposed lamps are not acceptable.

F. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.09 **DELIVERY, STORAGE, AND HANDLING**

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 **COORDINATION**

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.11 **WARRANTY**

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) or manufacturer’s standard warranty length (whichever is longer) from date of Substantial Completion.

PART 2 PRODUCTS

2.01 **LUMINAIRES (LIGHTING FIXTURES)**

A. Provide Luminaires as indicated on drawings.

2.02 **LUMINAIRE REQUIREMENTS**

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. Unless otherwise specified in Luminaire product data, provide products with a minimum CRI of 80.

D. Unless otherwise specified in Luminaire product data, provide products with a CCT of 50000 K.

E. Unless otherwise specified in Luminaire product data, provide products with an IES LM-80 rated lamp life of 50,000 hours.

F. Driver

1. Provided as an integrated component of the luminaire or as an external component of an assembly of luminaries.

2. Nominal Input Voltage: All drivers shall be rated for use on either 120V or 277V systems.

2.03 EXIT SIGNS

A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps: Light-emitting diodes, 70,000 hours minimum of rated lamp life.

2.04 EMERGENCY LIGHTING UNITS

A. General: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.

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. Wire Guard: Where indicated, heavy-chrome-plated wire guard protects lamp heads or fixtures.

2.05 EMERGENCY AUTOMATIC LOAD CONTROL RELAY

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

1. Bodine BLCD Series.

2. Nine-24, Inc.: ELCR Series.

3. LVS, EPC Series.

4. IOTA, ETS-20 Series.

5. Functional Devices, Inc., ESR Series.

6. ETC, ALCR Series.

7. Wattstopper, ELCU series.

B. Description:

1. The Automatic Load Control Relay (ALCR) shall provide required functionality to allow any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area of the building.

2. The ALCR shall allow control of emergency lighting fixtures in tandem with normal lighting in an area while ensuring that emergency lighting will turn on immediately to full brightness upon loss of normal power supplying the control device.

3. Emergency lighting operation shall be independent for each controlled area and shall not require a generalized power failure for proper operation.

4. Self-contained with integral ½” nipple mount with snap in locking feature for mounting into a standard junction box knock out.
5. Normally closed dry contacts capable of switching 20 amp emergency ballast loads @ 120-277 VAC, 60 Hz, or 10 amp tungsten loads @ 120 VAC, 60 Hz.
6. Universal rated voltage inputs provided for normal power sense and normal switched power at 120-277 VAC, 60 Hz.
7. Integral momentary test switch. Pressing and holding this switch shall instantly force the unit into emergency mode and turn on emergency lighting. Releasing the test switch shall immediately return the unit to normal operation.
8. Dedicated leads and 24 VDC source for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure. Breaking contact between the terminals shall force and hold the emergency lighting on until the terminals are again closed. An integral LED indicator shall indicate the unit’s current remote activation status.
9. Separate LEDs to indicate the presence of normal and emergency power sources. The LEDs shall indicate the unit’s current operational mode (normal or emergency).
10. Normal power input leads shall be connected to the line side of the control device such that any upstream fault causing a loss of power, including the tripping of the branch circuit breaker, will force the unit into the emergency mode and turn on the emergency lighting.
11. Automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.
12. Utilize zero crossing circuitry to protect relay contacts from inrush current.
13. Plenum rated housing equipped with compression flying leads.
14. The unit shall be UL listed to the UL924 standard and labeled for connection to both normal and emergency lighting power sources.

C. Provide device with proper rating for total load and load type being transferred

D. Provide for devices suitable for line voltage and low voltage dimming control where required such that device bypasses dimming control signal to luminaire to provide full output upon loss of normal power.

E. Coordinate with luminaire product data, lighting control schedules and details and diagrams included on the drawings for dimming characteristics.

2.06 BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH

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

1. LVS EPC-D-F-ATS Series
2. Bodine.

B. Description: Localized load transfer switch to allow emergency fixture to be powered and controlled by the normal lighting circuit, sense presence of normal power ahead of control circuit and switch luminaire (both line and neutral) over to emergency source upon loss of normal source.

C. Universal dimming capability to allow the lighting to be controlled and dimmed by the normal lighting circuit during normal times. In the event of a loss of the normal branch circuit, and transfer the designated emergency fixtures form normal dimming control to the emergency

power source and bring them to full brightness, regardless of the current state of the dimming system.

D. Device shall be mounted remotely for each control circuit as application requires.

E. Listed and labeled by an NRTL to the UL1008 for emergency operation and listed for field installation.

F. Integral test switch and indicating lamps to indicate status.

G. Provide device with proper rating for total load and load type being transferred

H. Coordinate with luminaire product data, lighting control schedules and details and diagrams included on the drawings.

2.07 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. 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.

C. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598 Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter, shape, size, wattage, and coating.
   c. CCT and CRI for all luminaires.

2.08 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.09 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: Unless otherwise specified in Luminaire product data, provide products with a minimum 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: Unless otherwise specified in Luminaire product data, provide products with a minimum ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: Unless otherwise specified in Luminaire product data, provide products with a minimum 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.01 EXAMINATION

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

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TEMPORARY LIGHTING

A. Do not use permanent luminaires for temporary lighting.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and N.E.C.A./I.E.S.N.A. 500-2006 and 502-2006.

B. Locate ceiling luminaires as indicated on reflected ceiling plan.

C. Support luminaires independent of ceiling framing. Support recessed grid luminaries from two opposite corners directly to structure. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

D. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.

E. Install recessed luminaires to permit removal from below.

F. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

G. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

H. Install fixture with no gaps between adjacent fixtures or between fixtures and surrounding surfaces. Trims of fixtures shall be properly and uniformly aligned.

I. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

J. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

K. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

L. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
2. Ceiling mount with pendant mount four-point pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
3. Ceiling mount with hook mount.

M. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing, stem or wire support for wiring at one point and tubing, rod or wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

N. Comply with requirements in Section 26 0519 "Conductors and Cables" for wiring connections.

O. Fixtures shall have their exterior labels removed and shall be thoroughly cleaned.

P. Locate the remote test/monitor modules identically so that they are visible and they form a straight line when viewed from the end of the corridor or room. Where a suspended ceiling exists, center the modules in adjacent ceiling tiles.

3.04 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

C. Bond products and metal accessories to branch circuit equipment grounding conductor.

D. Connect luminaires to branch circuit outlet boxes provided under Division 26 Section "Raceways and Boxes" using 1/2" flexible conduit.

3.05 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.06 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

D. A visual inspection shall be performed to verify cleanliness and alignment of the fixtures, misalignment and light leaks shall be corrected, and rattles due to ventilation system vibration shall be eliminated.

3.07 **STARTUP SERVICE**

A. Comply with requirements for startup specified in Division 26 Section "Lighting Control Systems."

3.08 **ADJUSTING**

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps, drivers, or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

B. Adjust exit sign directional arrows as indicated on Drawings.

C. Adjust and calibrate all dimming system controls until the system works as designed. Contact the Architect/Engineer when dimming is complete and demonstrate operation to owner’s representative and Architect/Engineer.

3.09 **CLEANING**

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures and lenses.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

END OF SECTION

SECTION 26 5600 - EXTERIOR LIGHTING

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with LEDs and drivers.
2. Poles and accessories.

B. Related Sections include the following:

1. Division 26 Section "LED Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.03 DEFINITIONS

A. CRI: Color-rendering index.

B. Luminaire: Complete lighting fixture, including ballast housing if provided.

C. Pole: Luminaire support structure, including tower used for large area illumination.

D. Standard: Same definition as "Pole" above.

1.04 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.

C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph.

1.05 **ACTION SUBMITTALS**

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Details of attaching luminaires and accessories.

3. Details of installation and construction.

4. Luminaire materials.

5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Drivers, including energy-efficiency data.

7. LED’s, including life, output, and energy-efficiency data.

8. Materials, dimensions, and finishes of poles.

9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

10. Anchor bolts for poles.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

2. Wiring Diagrams: Power wiring.

1.06 **INFORMATIONAL SUBMITTALS**

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

B. Qualification Data: For agencies providing photometric data for lighting fixtures.

C. Field quality-control test reports.

1.07 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

B. Warranty: Special warranty specified in this Section.

1.08 **QUALITY ASSURANCE**

A. 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.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.09 **DELIVERY, STORAGE, AND HANDLING**

A. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

B. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.10 **WARRANTY**

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.

2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.

3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

4. Warranty Period for LEDs: Replace LEDs and fuses that fail within 5 years from date of Substantial Completion.

5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five years from date of Substantial Completion.

1.11 **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. LED Drivers 5% attic stock of each type and rating installed. Furnish at least one of each type.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2. Basis of Design Product: The design of each item of exterior luminaire and its support 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.

2.02 **LUMINAIRES, GENERAL REQUIREMENTS**

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.03 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

2.04 **STEEL POLES**

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.

1. Mounting Provisions: Butt flange for bolted mounting on foundation.

B. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.

3. Match pole material and finish.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

F. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

2.05 **POLE ACCESSORIES**

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

B. Vibration Dampener: For all steel and aluminum lighting poles taller than 25’, provide factory installed vibration dampening device to eliminate second mode or higher resonance that can occur with low velocity steady state winds.

2.06 **REQUIREMENTS FOR INDIVIDUAL EXTERIOR LIGHTING DEVICES**

A. Provide Luminaires as included in specification 26 5700 “Luminaire Product Data.” This section contains product data sheets from the basis of design manufacturer with annotations.

B. Acceptable alternate manufacturers are indicated on the product data sheets. Alternate manufacturer products shall be equal in all respects including materials, finishes, photometric performance and energy performance and shall include all options, features, and accessories identified.

C. The Luminaire schedule shown on the drawings is supplemental provided for convenience and reference only. The requirements of this section and 26 5700 shall govern.

PART 3 EXECUTION

3.01 **LUMINAIRE INSTALLATION**

A. Install exterior lighting system per N.E.C.A./I.E.S.N.A. 501-2006.

B. Fasten luminaire to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming.

3.02 **POLE INSTALLATION**

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.

3. Trees: 15 feet.

C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Install base covers, unless otherwise indicated.

D. Raise and set poles using web fabric slings (not chain or cable).

3.03 **CORROSION PREVENTION**

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.04 **GROUNDING**

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding."

3.05 **FIELD QUALITY CONTROL**

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

END OF SECTION

SECTION 26 9413 - FUNCTIONAL PERFORMANCE TESTING FOR POWER AND LIGHTING CONTROLS

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PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for Functional Performance Testing (FPT) of building systems and equipment to verify compliance with sequences of operation.

B. FPT applies to power and lighting systems covered by ASHRAE 90.1 version currently adopted by Michigan Energy Code, whether or not project commissioning is specified.

C. When commissioning is specified, FPT requirements in this Section are in addition to commissioning requirements in Division 01 Section "*Commissioning General Requirements*" and discipline-specific commissioning sections.

1.02 RELATED SECTIONS

A. 01 9113 – Commissioning General Requirements.

B. 26 0800 – Commissioning of Electrical.

C. Division 26 – Electrical.

D. Division 27- Communications

E. Division 28- Electronic Safety and Security

1.03 REFERENCES

A. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, version as currently adopted by Michigan Energy Code

B. International Energy Conservation Code (IECC), version as currently adopted by Michigan Energy Code.

1.04 DEFINITIONS

A. Commissioning Provider (CxP), also known as Commissioning Authority (CxA): an entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement building commissioning.

B. Commissioning: a quality-focused process for enhancing the delivery of a project for verifying and documenting that the building and its systems, controls, and building envelope are planned,

designed, installed, tested, and include plans for operation and maintenance to meet specified requirements.

C. Deficiency: A system or equipment condition that fails to perform as required.

D. Functional Performance Testing (FPT): a systematic process to verify that controls and other elements of the building project are capable of and configured to operate or perform as required. Dynamic functions and operations of equipment and systems shall be demonstrated using manual (direct observation) or monitoring methods. The systems are run through all the control system's sequences of operation and components are verified to respond as the sequence states.

E. Sequence of Operation (SOO): Control logic and response conditions specified in Contract Documents for mechanical, electrical, and control systems.

F. Verification and Testing Provider (V&T provider): an entity who completes the activities needed to implement the building Verification and Functional Performance Testing (FPT) activities. V&T Providers shall not be individuals who performed the design or installation.

1.05 **SUBMITTALS**

A. Preconstruction Submittals

1. Proposed testing plan, including systems, methods, responsibilities, and schedule.

2. Sample test forms and checklists for Engineer review.

B. Functional Performance Testing Reports:

1. Project commissioning documents shall comply with ASHRE/IES Standard 202 or other generally accepted engineering standards acceptable to the building official

2. Contractor shall prepare a written report for each functional performance test performed. Reports shall be compiled into a single electronic package for submission at project closeout. Each report shall include, at minimum:

a. System Identification – Name and description of the system or equipment tested, including tag or ID number.

b. Test Information – Date of test, location, weather/operating conditions as applicable.

c. Participants – Names, titles, and firms of personnel performing and witnessing the test.

d. Reference Criteria – Sequence of operation, code requirement, or specification section being verified.

e. Test Procedure – Step-by-step description of how the test was conducted, including setpoints, inputs applied, and expected responses.

f. Results – Measured or observed data, presented in tabular or checklist format where practical.

g. Pass/Fail Outcome – Clear indication of whether each step met requirements.

h. Deficiencies – Description of failed steps, issues encountered, or incomplete functions.

i. Corrective Actions – Description of adjustments, repairs, or programming changes made, with date of resolution.

j. Retest Results – Documentation of retest where deficiencies were corrected.

C. Final Compilation: Submit all functional performance testing reports as follows:

1. Single indexed PDF file (searchable text).

2. Electronic file shall be organized by discipline and system, with table of contents.

3. Reports shall be provided prior to request for Substantial Completion.

1.06 **QUALITY ASSURANCE**

A. Installing contractors shall provide a qualified technician experienced with verification or FPT to perform the verification and testing (V&T) of the designated systems. V&T providers shall not be individuals who performed design or installation of the systems or assemblies being verified or tested.

B. The Engineer and/or Owner's Representative may request to witness FPT activities.

C. V&T providers shall review the construction documents to verify that the relevant sensor locations, devices, and control sequences are properly specified; performance and testing criteria are included; and equipment to be tested is accessible for testing and maintenance.

D. Functional testing shall not begin until system installation, start-up, and balancing are complete and approved.

1.07 **COORDINATION**

A. Coordinate FPT schedule with Engineer and Owner to allow witnessing (if requested).

B. Provide a minimum of 14 days' notice prior to each test.

C. If applicable, commissioning is specified in the following sections:

1. 01 9113 – Commissioning General Requirements

2. 26 0800 – Commissioning of Electrical

D. Management: The V&T Provider shall coordinate the V&T activities through the Construction Manager and reports to the owner, A/E, CM, and (if applicable) Commissioning Provider. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

E. Scheduling: The V&T Provider with work with the CM to schedule the V&T activities within sufficient notice, and the CM will integrate all V&T activities into the overall project schedule. As construction progresses, more detailed schedules are developed. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the V&T process.

F. Manufacturers' Field Services: V&T Provider shall identify instances where manufacturers' field representatives are required, and the CM will coordinate their services.

PART 2 PRODUCTS

2.01 **INSTRUMENTATION**

A. Instrumentation shall be provided by the Contractor; provide all specialized tools, test equipment, and instruments required to execute verification and testing.

PART 3 EXECUTION

3.01 **PREPARATION**

A. Verify systems are complete and started prior to testing.

B. Verify that control systems are programmed, graphic interfaces are operational, and trending/logging functions are enabled.

3.02 **GENERAL TESTING REQUIREMENTS**

A. Where control sequences are referenced in this specification, refer to sequences of operation listed on contract documents.

B. Conduct FPT under normal and seasonal operating conditions as practical.

C. Document results in test forms, noting pass/fail status and corrective actions.

D. Correct deficiencies and retest until satisfactory performance is demonstrated.

3.03 **SYSTEM-SPECIFIC FUNCTIONAL TESTING**

A. Lighting Controls

1. Verify lighting control devices and control systems are calibrated, programmed and in proper working order according to the construction documents for the following (where applicable):

a. Occupancy sensors.

b. Automatic time switches.

c. Daylight controls.

B. Electrical Power and Distribution

1. Verify the control elements are configured and operating according to the construction documents for the following:

a. Automatic receptacle controls.

b. Electrical energy monitoring systems, including recording and reporting.

3.04 **ACCEPTANCE**

A. Submit completed FPT reports for each system.

B. Engineer and Owner will review and issue acceptance or request additional corrective action.

C. Successful completion of FPT is a condition of Substantial Completion.

END OF SECTION

SECTION 27 5123.60 – AREA OF RESCUE ASSISTANCE TWO-WAY INTERCOMMUNICATION SYSTEM

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes a complete, digital, audio-visual intercom system, including central annunciator and control panel, remote call stations, battery backup, power supplies, remote call station expansion switches, signage, and all other necessary auxiliary devices, boxes, raceway, and wiring to provide a complete and operational Area of Rescue Assistance Two-way Communications system.

1.03 ACTION SUBMITTALS

A. Product Data: For the following:

1. Central annunciator and control panel.
2. Remote call stations.
3. Power Supply with Battery Backup.
4. Auto-dialer.
5. Signage.

6. Fire resistive wire and cable.

B. Shop Drawings:

1. Equipment Details: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection.

2. Station-Arrangement Details: Scaled drawings for built-in equipment.

3. Wiring Diagrams: Power, signal, and control wiring. Include the following:

a. Identify terminals to facilitate installation, operation, and maintenance.

b. Single-line diagram showing interconnection of components.

c. Cabling diagram showing cable routing.

d. Identify provisions to achieve NFPA 72 Survivability requirements

1.04 **INFORMATIONAL SUBMITTALS**

A. Qualification Data: For Installer.

B. Field quality-control test reports.

1.05 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For two-way communication equipment to include in emergency, operation and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures\Operation and Maintenance Data," include the following:

1. Record of final matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

1.06 **QUALITY ASSURANCE**

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than 4 hours' normal travel time from Installer's place of business to Project site.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70

D. Comply with NFPA 72

E. Comply with UL 50.

F. Comply with UL 2196

G. The contractor shall be an established communications contractor that has had and currently maintains a locally run and operated business for at least five (5) years. The contractor shall utilize a duly authorized distributor of the equipment supplied for this project location with full manufacturer’s five (5) year warranty.

H. The contractor shall show satisfactory evidence, upon request, that the supplies and maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. Cornell Communications, Inc.
2. Tek-Tone Sound and Signal Manufacturing

2.02 **FUNCTIONAL DESCRIPTION OF TWO-WAY INTERCOMMUNICATION SYSTEM**

A. Basic system consists of central annunciator and control panel with system power supply and built-in battery backup, remote call stations, and related signage.

B. Other components include a telephone system auto-dialer for off-site notification at a secondary location, usually 9-1-1 emergency service.

C. When a call is placed to the central annunciator and control panel, from a remote call station, the following occurs:

1. Audible and visual notification at the call station to indicate that a call has been initiated.
2. Audible and visual notification at the central annunciator and control panel which indicates that a call from a remote call station has been initiated and also identifies the remote call station location.
3. After initiation, the control station operator must manually reset the visual notification of each call location at the control station to terminate the notification.
4. After initiation, the control station operator must acknowledge the audible notifications that the call was placed at the control station, to terminate the notification.
5. After initiation, the control station operator must manually reset the visual notification at the remote call station.

D. When a call from a remote call station is acknowledged at a central annunciator and control panel, the following occurs:

1. Visual notification at the central annunciator and control station that the call has been acknowledged.
2. Visual notification at the remote call station that the call has been received.
3. Two-way intercommunication is established between the remote call station and the central annunciator and control panel.

E. When a call is placed to the central annunciator and control panel, from a remote call station, and is not acknowledged at the central annunciator and control panel, the following occurs:

1. After a programmed time delay, 9-1-1 is dialed from an automatic telephone dialer and a pre-recorded message is played, and two-way voice communication is established between the remote call station and the dialed emergency responder number.

2.03 **EQUIPMENT AND MATERIALS**

A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Modular type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.

2.04 **CENTRAL ANNUNCIATOR AND CONTROL STATION**

A. Wall mounted central annunciator and control station with handset for two way communication to remote call stations. Provide flush mounting of wall mounted station.

B. Provide visual annunciation of remote call station via individual red LED lamps for each remote station and integral scrolling message screen indicating status and location of individual remote call station at central annunciator and control station.

C. Provide audible annunciation of remote call station call at central annunciator and control station.

D. Provide password protected memory with local and remote programming ability. Program shall identify the specific location of the remote call station.

2.05 **EXPANSION SWITCH**

A. Switch shall be designed to expand the system capacity by 1-8 devices including remote call stations, other expansion switches, and remote control panels.

B. Provide a surface mounted enclosure to house expansion switch. Mount adjacent to central annunciator and control station.

2.06 **REMOTE CALL STATIONS**

A. Provide recessed, hands free, vandal resistant, speaker phone with stainless steel faceplate including a red call button (push once to talk), and a red LED to indicate status of the call.

B. Faceplate identification shall include versions of the following: “Help Phone”, the international phone symbol, and raised Braille lettering in conformance with ADA requirements.

2.07 **SYSTEM POWER SUPPLY WITH BATTERY BACKUP**

A. Provide 120V. 60 Hertz input, 24V output, nickel cadmium battery backup for system operation. Provide flush or surface mounted battery enclosure as indicated on drawings. Provide AC power failure and low battery indicators. Batteries shall maintain system operation for 4 hours in case of power failure. Provide 5 year average battery life. Quantities shall be as required for complete system support.

2.08 **SYSTEM AUTO-DIALER**

A. Provide an integrated automated system dial-out capability to dial a pre-programmed telephone number to directly connect a remote call station to a remote emergency responder telephone number for two-way voice communication.

2.09 **CONDUCTORS AND CABLES**

A. Provide wiring as recommended by Area of Rescue Assistance Two-Way Intercommunication System Manufacturers.

B. Conductors: Jacketed, twisted pair and twisted multi-pair, untinned solid copper. Sizes as recommended by system manufacturer, but not smaller than No. 22 AWG.

C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG tinned, soft-copper strands formed into a braid or equivalent foil.

1. Minimum Shielding Coverage on Conductors: 60 percent.

D. Plenum Cable: Listed and labeled for plenum use.

E. Pathway Survivability:

1. Provide wiring with pathway survivability minimum Level 3 with one or more of the following options:

a. 2-hour fire rated circuit integrity (CI) cable

b. 2-hour fire-rated cable system (electrical circuit protective systems)

c. 2-hour fire rated enclosure or protected area (only where specifically identified on drawings)

2.10 **ILLUMINATED SIGNAGE**

A. Provide instructional, tactile, and illuminated signage indicating the location and use of emergency two-way communications system.

B. Instructional signage detailing the use of the two communications system shall be posted on or adjacent to the remote call stations.

C. Tactile and visual signage shall be located at the entrance to each elevator lobby indicating that the two-way emergency communication system is available in area (location of remote call station).

D. Illuminated signage indicating Emergency Communications location (location of remote call station) shall be located at entrance to each elevator lobby and in path of egress indicating that the two-way emergency communication system is available in the area (location of remote call station).

PART 3 EXECUTION

3.01 **INSTALLATION**

A. Wiring Method: Install wiring in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where cable wiring method may be used. Use plenum cable in environmental air spaces, including plenum ceilings. Conceal cables and raceways except in unfinished spaces.

B. Install circuit integrity cable and fire resistive cable systems in accordance with the manufacturer’s installation guidelines and in accordance with UL listing requirements.

C. Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by J- hooks or similar fittings designed and installed to avoid damage to cables. Secure cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

E. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

F. Separation of Wires: Separate two way communication system equipment conductors as recommended by equipment manufacturer.

G. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

H. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

I. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

J. Connect wiring according to Division 26 Section "Conductors and Cables."

K. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

L. Mounting Heights: Remote Call Station – 48 inches from floor to center of device; Central Annunciator and Control Station – 60 inches to center of station, unless desk mounted type; Instructional Signage – 48 inches to center; Tactile signage – 60 inches to center; Illuminated signage – between 60 and 80 inches.

3.02 **GROUNDING**

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at central annunciator and control panel. Isolate from power system and equipment grounding.

3.03 **SYSTEM PROGRAMMING**

A. Programming: Fully train Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.04 **FIELD QUALITY CONTROL**

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing two-way emergency intercom system equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Test two way communications between originating remote call station and central annunciator and control station. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Frequency Response Test: Determine frequency response by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings using a 1000-Hz signal. Measure between central annunciation and control panel and remote control stations. Minimum acceptable ratio is 45 dB.
6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each remote call station and central panel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
7. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
8. Power Output Test: Measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB.
9. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Division 26 Section "Grounding and Bonding."

C. Retesting: Correct deficiencies and retest. Prepare a written record of tests.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

E. Prepare written test reports.

1. Include a record of final signal ground-resistance measurement certified by Installer.

3.05 **STARTUP SERVICE**

A. Engage a factory-authorized service representative to perform startup service and initial system programming.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.06 **ADJUSTING**

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.07 **DEMONSTRATION**

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain two-way communication equipment. Refer to Division 1 Section "Demonstration and Training."

1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment.

END OF SECTION

SECTION 28 1000 – TECHNOLOGY OVERVIEW

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section provides a project overview and general project and Contractor requirements for technology work.

B. The “Contractor” as referred to in these specifications, shall be the bidder whose bid is eventually chosen as the winner.

C. The “Engineer” as referred to in these specifications, shall be Commtech Design and its representative on this project.

D. The “Owner” as referred to in these specifications, shall be Dexter Community Schools and its representatives.

E. In the detailed specifications and on the contract drawings, the phrases “or equivalent,” “approved equivalent,” “approved equal,” “or equal” and “engineer approved equivalent” shall be used interchangeably and shall mean the same thing.

F. All equals, equivalents, or alternates shall be approved by the Engineer prior to ordering or installation. Without approval, deviation from the products listed in the specifications and on the drawings, shall be presumed to be nonconforming and shall be removed and replaced at the direction of the Engineer and at the Contractor’s expense.

1.02 DESCRIPTION OF PROJECT

A. Cabling and communications infrastructure.

1. The communications portion of the project encompasses communications cabling and termination equipment. The work shall include but not be limited to:
    a. Communications room racks and cabinets.
    b. Communications Cabling and Termination Equipment:
    a. User UTP Plenum rated CAT-6 and CAT-6A cabling
    b. Fiber optic cabling and termination.
        1) Terminate and test each fiber strand. Terminate into panels at each end.
2. All cables shall be labeled according to the drawings and the specifications.
3. All cables shall be terminated and tested as per the specifications.
4. Contractor shall provide personnel and equipment for full training and commissioning of the system.
2. All cables shall be supported by J-hooks or cable tray/ladder.
3. Label all cables
4. Test all cables.
5. The extent of the work shall be as shown on the drawing and detailed in these specifications

B. Audio and Video Systems

1. The audio and video systems in the building shall consist of but not be limited to:
    a. Meeting room AV systems
    b. Large room AV systems
    c. Fieldhouse Audio system
2. Test all AV systems
3. The extent of the work shall be as shown on the drawing and detailed in these specifications

C. Access Control System

1. Install an access control system in the building(s).
    a. Provide and install all equipment and software required.
    b. The existing system is a Lenel S2 System
    c. Expansion of this system shall include Mercury hardware for all new doors equipment.
2. Install all cabling required connect each door to the security panels
    a. Security panels shall be located in each communications room. See drawings.

b. Wire from each power supply to the panels and to the devices at the doors

3. Install intercoms. Where the intercom is connected to the data network the contractor shall provide all patch cables and configure the network to support the intercoms
4. Configure the system as per the owner's requirements. Meet with them to determine configuration parameters
5. The extent of the work shall be as shown on the drawing and detailed in these specifications

D. Video Security System
1. The existing system is a Digital Watchdog video security system. It shall remain and be expanded as part of this project.
2. See drawings and specs for CAT-6/6A cable installation and who is responsible for installing cabling.
3. Provide and install all cameras at all locations noted
4. Provide and install servers and software for monitoring and recording all new security cameras plus any spare processing and space as detailed in the Security Recording specification.
5. Fully configure all software and hardware required for recording of camera images
6. Install viewing software on owner's computers and devices.
7. The extent of the work shall be as shown on the drawing and detailed in these specifications

E. Clock System
1. The master clock system shall be installed throughout the buildings as shown on the floorplans.
2. All cables shall be terminated and tested as per the specifications.
   a. All cables shall be supported by J-hooks in the ceiling.
   b. Label all cables
   c. Test all cables.
3. Contractor shall provide personnel and equipment for full training and commissioning of the system.
4. The extent of the work shall be as shown on the drawing and detailed in these specifications.

F. Post installation documentation
1. Each contractor shall provide post installation documentation as per the specifications. Shall include but not be limited to:
   a. Red-lined as-built drawings
   b. As-built detailed connectivity and floorplan locations of cabling, AV and security Systems
   c. As-built cable locations and cable labels at each location.
   d. Mark all splice locations for any cabling.
   e. Update of all access control locations and equipment at each door
   f. Camera locations and camera numbers.
   g. Spreadsheet (hard copy and Excel file) for all network, Wireless, telephones and cameras detailing:
      1) Mfg. Part number
      2) IP Address
      3) MAC Address
      4) Device number (Camera #, Telephone # etc)

1.03 STORAGE OF MATERIALS

A. All materials shall be secured when not in use by the Contractor.

B. It shall be the Contractor's responsibility to secure all equipment including all material to be installed as part of the contract. No changes shall be made to the contract due to loss or theft of equipment and materials not officially accepted by the Owner.

1.04 PERMITS

A. The State of Michigan requires that the Contractor apply for and obtain permits for data telecommunication installation.
B. This is required under State of Michigan Public Act 230. The inspector at the State of Michigan states that the code never exempted data telecommunications from permits and previous rules had overstepped their bounds. Only exemptions to the permit requirements are found in Public Act 230 MCL125.1528a.
    1. There is not a license required to apply for a permit per Public Act 407 MCL339.5737(3)(o).
C. The Permit is required under Public Act 230. The permit is under 2017 Michigan Electrical Code rules Part 8.
D. People who can obtain the permit include the Owner of the building or a company representing the owner. See Public Act 230 MCL125.1510.
    1. Contractor shall be required to apply for and obtain the permit
    2. Contractor shall be required to install the data telecommunications system to fully meet all code requirements and requirements of the Inspector and Authority Having Jurisdiction (AHJ)
E. State inspector has noted that the inspection process for data telecommunications is the same as any other inspection.
    1. Do not cover or conceal any wiring without approval.
    2. Electrical Inspectors will be conducting the inspections.
    3. Contractor shall be responsible for scheduling the inspections and attending the inspections with the inspector
F. State inspector has noted that the inspectors will be inspecting for code compliance including manufacture's installation instructions for the cables and terminations.
G. An installation may not pass inspection if there is any Non-compliance with the code.

1.05 REFERENCE SPECIFICATIONS-CABLING

A. All work applicable shall conform to the following standards:
B. ANSI/TIA-568-C.0, "*Generic Telecommunications* Cabling *for Customer Premises*",
C. ANSI/TIA-568-C.1, "*Commercial Building Telecommunications Cabling Standard*",
D. ANSI/TIA-568-C.2, "*Balanced Twisted-Pair Telecommunication Cabling and Components Standard*", ANSI/TIA-568-C.3, "*Optical Fiber Cabling Components Standard*",
E. ANSI/TIA-568-C.4, "*Broadband Coaxial Cabling and Components Standard*",
F. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
G. IA-606-B: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings including all Updates and Addenda.
H. TIA-607-C: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
I. EIA-472 General Specification for Fiber Optic Cable
J. EIA-472A Sectional Specification for Fiber Optic Communication Cables for Outside Aerial
K. EIA-472B Sectional Specification for Fiber Optic Communication Cables for Underground and Buried Use
L. EIA-472C Sectional Specification for Fiber Optic Communication Cables for Indoor Use
M. EIA-472D Sectional Specification for Fiber Optic Communication Cables for Outside Telephone Plant Use
N. NEC, 2015, or latest edition available
O. IEEE 802.3af PoE • Ratified in 2003 • 15.4W at the PSE, with min of 12.95W available to the PD
P. IEEE 802.3at PoE+ • Ratified in 2009 • 34.2W at the PSE, with min of 25.5W available to the PD
Q. IEEE 802.3bt-2018 - IEEE Standard for Ethernet Amendment 2: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs

1.06 REERENCE STANDARDS NETWORKING

A. EE 802.3™: Ethernet
B. IEEE 802.11™: Wireless Lans
C. IEEE 802.22™: Wireless Regional Area Networks
D. TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
E. IEEE 802.3af PoE • Ratified in 2003 • 15.4W at the PSE, with min of 12.95W available to the PD
F. IEEE 802.3at PoE+ • Ratified in 2009 • 34.2W at the PSE, with min of 25.5W available to the PD
G. IEEE 802.3bt-2018 - IEEE Standard for Ethernet Amendment 2: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs

1.07 CONTRACTOR-ALL

A. Each contractor shall be responsible for inspecting their own work and ensuring it meets the project requirements.
B. Contractor shall have a project manager who will be responsible for all work, workers, equipment, cabling and project management for their work. The project manager shall have the authority to make decisions for the contractor and schedule all workers.
C. Contractor shall attend all project meetings throughout the project.
D. All work on the project shall meet all applicable state, federal, local and industry codes and be installed according to the requirements of he Authority Having Jurisdiction (AHJ).
E. Contractor shall provide all equipment, man-lifts, ladders, transportation etc, required to install all specified cabling and equipment.

1.08 CONTRACTOR -CABLING

A. The Contractor shall have a BICSI certified Registered Communications Distribution Designer (RCDD) identified that will be responsible for all aspects of the installation. (This person does not have to be a direct employee of the bidder but must inspect the work to ensure that it is done based on standards)
    1. The resume of the RCDD, and a list of past projects the RCDD has worked on, shall be submitted with the submittal package. The Engineer reserves the right to reject the RCDD, and require the Contractor to assign another if the RCDD is found not to have sufficient experience in projects of relatively the same scope.
    2. If during the course of the work, the Contractor changes the RCDD assigned to the project, the Contractor shall provide the resume of the new RCDD and a list of projects of similar scope the new RCDD has worked on.
B. The Contractor shall show proof of an existing contractual relationship with the approved equipment manufacturer of the horizontal cabling system, and shall pass through the manufacturer's certification and warranty to purchaser.
C. All faceplates and termination hardware shall be sourced from the certifying manufacturer to assure quality control and validity of the manufacturer's warranty.
D. The Contractor shall accept complete responsibility for the installation, certification, and support of the cabling system. Contractor must show proof that he has the certifying manufacturer's support on all of these issues.
E. All work shall be performed and supervised by Telecommunications Technicians and Project Managers who are qualified to install voice, data, and image cabling systems, and to perform related tests as required by the manufacturer in accordance with the manufacturer's methods.
F. The Telecommunications Technicians employed shall be fully trained and qualified by the manufacturer on the installation and testing of the equipment to be installed. Evidence that the vendor is a current Certified Installer of the manufacturer must be provided in writing prior to work commencing on the structured cabling for the building.
G. The Contractor (including Subcontractor(s) if any) shall have a proven track record in cabling projects. This must be shown by the inclusion of details of at least 3 projects involving Category 6 or better cabling and optical fiber, which have been completed by the vendor in

the last 2 years. Names, addresses, and phone numbers of references for the 3 projects shall be included.

1.09 CONTRACTOR –AUDIO/VIDEO

A. The Contractor shall accept complete responsibility for the installation, certification, and support of the system. Contractor shall show proof that they have the certifying manufacturer's support on all of these issues.

B. All work shall be performed and supervised by Audio/Video Technicians and Project Managers who are qualified to install audio/video systems and cabling and to perform related tests as required by the manufacturer in accordance with the manufacturer's methods.

C. The Audio/Video Technicians employed shall be fully trained and qualified by the manufacturer on the installation and testing of the equipment to be installed.

D. The vendor (including Subcontractor(s) if any) shall have a proven track record in audio/video system configuration and installation. This must be shown by the inclusion of details of at least 3 projects involving the installation of like sized audio/video systems that have been completed by the vendor in the last 2 years. Names, addresses, and phone numbers of references for the three projects shall be included.

E. Sound/Video Contractor shall have at minimum 1 NICET level 2 project manager and 1 NICET level 1 certified installer/technician.

F. The Contractor shall utilize the following equipment in configuring and testing the audio signals for final system tuning:

1. TEF Analyzer, Smart-Pro Analyzer, Calibrated Microphone, Impedance Meter and Noise Generator

1.10 CONTRACTOR –SECURITY

A. The Contractor shall show proof of an existing contractual relationship with the approved equipment manufacturer of the video security system and access control system and shall pass through the manufacturer's certification to purchaser.

B. All hardware shall be sourced from the certifying manufacturer to assure quality control and validity of the manufacturer's warranty.

C. The Contractor shall accept complete responsibility for the installation, certification, and support of the security system. Contractor must show proof that he has the certifying manufacturer's support on all of these issues.

D. All work shall be performed and supervised by security technicians and project managers who are qualified to install security systems, and to perform related tests as required by the manufacturer in accordance with the manufacturer's methods.

E. The security technicians employed shall be fully trained and qualified by the manufacturer on the installation and testing of the equipment to be installed. Evidence that the vendor is a current certified installer of the manufacturer must be provided in writing prior to work commencing on the video security system.

F. The Contractor (including Subcontractor(s) if any) shall have a proven track record in security projects. This must be shown by the inclusion of details of at least 3 projects similar in scope and requirements which have been completed by the vendor in the last 2 years. Names, addresses, and phone numbers of references for the 3 projects shall be included.

PART 2 - PRODUCTS

2.01 FIRESTOPPING

A. Each contractor shall be responsible for firestopping around their cables and the raceways.

B. Shall be completed inside and around all conduits after cable installation.

C. Firestop for the area between the cable and the edge of the conduit shall be Nelson No. FSP, CLK or LBS+. Contractor shall install the best firestop for each individual installation.

1. Firestop shall be installed with regard to local and national building codes.
2. The firestop shall be a putty like substance that expands under heat and will not allow flame to pass for a designated period of time.

3. Firestop shall conform to all NEC, NFPA, and UL requirements.
4. Some wall pass-thru' s are shown on the drawings. The Contractor shall utilize these where possible.
5. Where the contractor must install cables through a wall where there is no pass-thru already provided, the Contractor shall be responsible for installing a fire-rated pass-thru and fire-stopping the conduit after cable installation.

D. Firestopping is required at all riser conduits and all pass thru's.
1. Each cable tray penetration of a wall shall be firestopped after cable installation. Use pillow type firestop to allow additional cables to be installed in the future.
2. Where riser conduits pass through floors, the area between the concrete and the conduit shall be firestopped. This shall be completed with a putty or liquid firestop product. Fill in the space with mineral wool, and then install the firestop on top. All firestop shall be of sufficient thickness to secure the rating required by code.
3. After final cable installation, install a putty firestop around all cables where they enter and exit conduit pass thru's and conduit risers.
4. All firestop shall be installed to provide the fire rating as described by local fire code.
5. It shall be the responsibility of the Contractor to verify that all conduits, walls, and raceways required to be firestopped have been firestopped.

E. Contractor shall provide a label at each penetration and firestop location detailing the UL rated fireproofing solution that was used in the specific application.
1. Apply sticker to the wall near the firestopped conduit.
2. Provide a sample of the label to the designer for review as part of the submittals.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Contractor shall be familiar with the location(s) where the work will be done. No additional compensation will be made for items the Contractor claims he was not aware of during bidding.

B. Work Area:
1. All work areas shall be cleaned at the end of each day. All debris shall be cleaned and removed from the site and disposed of in the approved container for the site.
2. All equipment shall be moved out of common areas and stored in the Contractor's lay down area, or in other approved storage locations on site.
3. Any work that is low hanging, or may otherwise impede the general use of the space, and cannot be removed, shall be flagged and cordoned off by the Contractor.

C. All equipment and parts shall be installed in a neat and workmanlike manner. Good installation principles shall be used throughout the project.

D. All cables routed above the drop ceiling or in the ceiling area shall be installed square to the building. Diagonal cable runs are not permissible.

E. All cut edges of conduits, boxes, raceway, etc., shall be trimmed and filed so that no burrs or rough edges will damage cable as it is installed.

F. All surface raceways, including conduits in exposed areas shall be painted to match the existing colors of the surrounding area.

G. If, in the course of the work, the Contractor damages, marks, or misplaces any ceiling tiles, the Contractor shall repair, and/or replace the ceiling tile to the original condition.
1. The Engineer shall decide if ceiling tiles have been damaged. Based on the Contractors proposed fixes, the Engineer shall decide the best course of action to repair any damage done by the Contractor to the ceiling tiles.

H. It shall be the responsibility of the Contractor to repair any damage done to the structure or finishes in the building by the Contractor. The building shall be returned to its original condition prior to final sign off of the project.

I. Firestop shall be installed to meet national and local codes.

3.02 DOCUMENTS

A. The Contractor shall fully read the contract documents including the detailed specifications, and the detailed drawings.

B. No additional compensation shall be made for any portion of the project which the Contractor did not know of or understand prior to providing the bid response.

C. In the case of any discrepancies between the detailed drawings and the detailed specifications, the Contractor shall provide the higher quality or more stringent requirement.

3.03 WORK PLAN-POST BID (CHOSEN CONTRACTOR ONLY)

A. Along with the submittals the Contractor shall provide a work plan for the implementation of the system they are installing. The plan shall include scheduled dates for major milestones, and all phases required for completion prior to final cutover.

B. The work plan shall list all items that must be completed by the Contractor or Owner to provide a smooth install of the system. The Contractor shall be responsible for all costs associated with the planning and cutover. The Owners only responsibility is to act as a liaison between the Contractor and the users.

C. The work plans shall include a time-line and a cutover date for the systems within each building. Contractor shall be responsible for all aspects of scheduling the work, including notification of the users, the administration, and the telephone service provider.

D. The work shall commence within 10 days of award of the contract. The Contractor shall be responsible for attending weekly project meetings at the Owner’s site to report on progress and keep the project team informed of the work being done

E. The work plan will be reviewed at each project meeting for compliance and updates.

F. Work shall immediately begin on site surveys to determine the existing infrastructure, conduit and raceway placement and determining placement of new system equipment. The Contractor shall be responsible for moving, relocating, and reconnecting any and all existing equipment required for the installation of the new systems.

G. After work plan and system approval by the Engineer the Contractor can begin work on infrastructure work that does not impede users.

H. The Contractor shall be responsible for working with the Owner’s Information Technology staff and administrators.

END OF SECTION 28 1000

SECTION 28 1100 – COMMUNICATIONS ROOM

PART 1 - GENERAL

1.01 SECTION INCLUDES
- A. Parts and equipment required for equipment in the communications room (Comm Room)

1.02 SYSTEM DESCRIPTION
- A. All equipment in the communications room shall be installed so that access is provided to all components, mechanical and electrical.
- B. All components of the communications room shall work together to form a cohesive and complete communications infrastructure.

1.03 COORDINATION
- A. Coordinate rack/cabinet work with the Electrical Contractor for placement of electrical connections.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
- A. Approved Equals for Racks and Cable Ladder Hardware:
  1. Hubbell.
  2. Ortronics
  3. Panduit.
  4. Great Lakes Case and Cabinet.
  5. Middle Atlantic.
  6. Hoffman

2.02 COMMUNICATIONS RACKS
- A. Four-post adjustable rack with front and back mounting rails.
  1. Rack shall be adjustable for depths between 21 inches and 32 inches. Adjustment shall be in increments of 1/2 inch.
  2. Rack shall have universal mounting holes on the front and back rack rails
  3. Rack shall be black in color.
  4. Rack shall be Ortronics # 19-84-T4SDA2132 or equal. Tapped holes
  5. Equip with two (2), vertical Organizers for installation between and on each side of a rack.
- B. Vertical organizers for racks
  1. Provide and install vertical organizers for new and existing racks as shown on the drawings
  2. Shall be front and back organizer. Front shall have a cover. Rear shall have cabler containment gates
  3. Shall be 7’ tall. 6” wide and single sided. No back organizing is required.
  4. Vertical organizer shall be able to be mounted to side of existing racks. Custom fit this. If rack is smaller than 7/ then cleanly cut the organizer to fit.
  5. Move cables and route the cables into the organizer to neatly route cables. Remove all items from the side of existing racks and install into the organizer.
     a. 6” wide Vertical organizer shall be
        1) RXL #3326-BK06 or
        2) Hubbell #VME67
  6. Where there is not 6” of space available, the vertical organizer shall be 4” wide, RXL # 3326-BK04. Confirm onsite at each rack prior to ordering.

2.03 POWER STRIPS:
- A. 20 AMP vertical power strip
  1. Single circuit 120 Volt, 20 AMP

2. Receptacles shall be NEMA 5-15/20R Quantity of 14.
3. Plug shall be NEMA l5-20P with 15' minimum cord. Include Adapter for 5-20P outlet
4. Circuit breaker with on/off switch
5. Two digit power meter showing total AMP usage
6. Raceway and all components shall be UL listed. The base and cover shall be black in color and shall be attached to the cable ladder of the rack system.
7. Provide all attachment hardware required to securely attach the outlet strip to the back of the vertical cable ladder or side of rack. Refer to detailed drawings for location.
8. Coordinate with electrician to verify plug and outlet in the wall connectivity.
9. Install and test all outlets prior to project completion.
10. Shall be Eaton #PDUMV20-36 equal

2.04 CABLE LADDER

A. Equip communication racks with cable ladder system for cable support and routing. Refer to Figure 28 110-A below.
   1. All cable ladders shall be custom cut to fit.
   2. Install cable ladder vertically behind each vertical organizer.
   3. Center the cable ladder on the vertical organizer so that when additional racks are added, the cable ladder can be used to serve both racks, and will not interfere with the components mounted in the rack.

B. Cable Ladder - Black and cut to length.
   1. 12" wide, 10' long cable ladder with channels. Hubbell #hsls1012B or equal.
   2. Equip with the following as required for a full installation as per the details and specifications:
      a. Relay Rack Mounting Kit, Hubbell #HLMPK19 or equal
      b. Wall support angle bracket, Hubbell #HLTSB12B or equal
      c. Corner clamp for connecting horizontal ladder on the top to the cable ladder that attaches to the wall. Hubbell #HLTK or equal.
      d. Wall saddle for attaching horizontal cable ladder section to the wall. Equipped with "J" bolts. Hubbell #HLX0612 or equal
      e. Cable Radius Drop for dropping cables down to vertical cable ladder between and to the side of each rack, Hubbell #HLCD12 or equal
      f. Foot Kit for Cable ladder at back of rack, Hubbell #HLRF or equal
      g. Butt Splice Kit, Hubbell #HSBSK or equal
      h. Swivel Splice kit, Hubbell #HLSSK or equal
      i. When mounting cable ladder along the wall, install supports to the wall, Hubbell #HLVWBK or equal
      j. Attach all cable ladders to the rack with unistrut and unistruts "L" and "T" connectors.
      k. Approved equals, Newton and Hubbell.

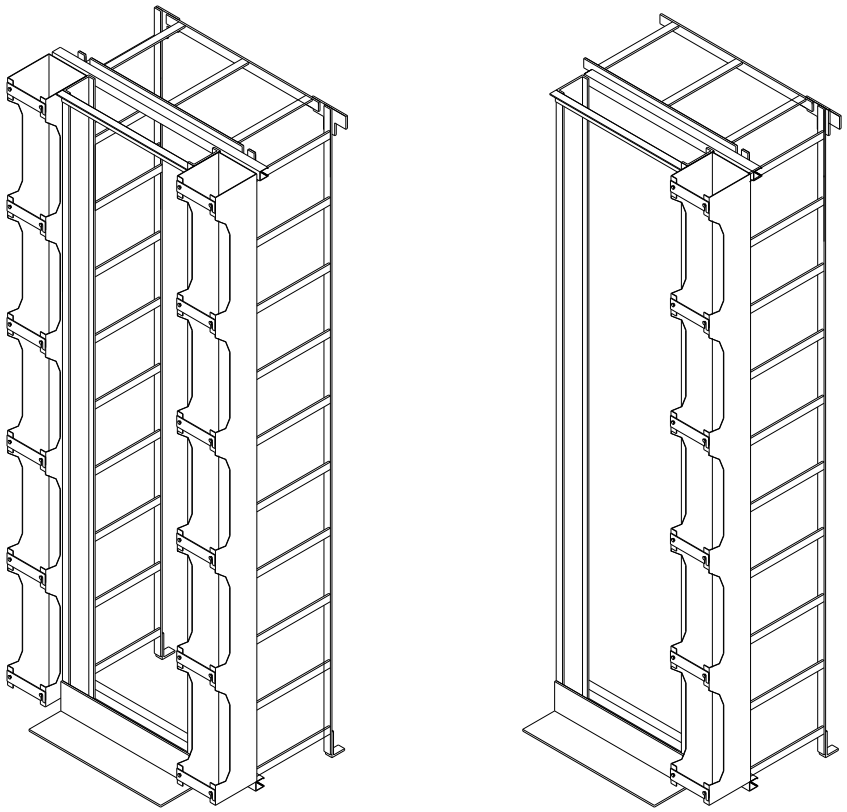


Figure 28 1100-A – Isometric View of Communications Racks

2.05 COMMUNICATIONS ROOM EQUIPMENT

A. Patch Cord Organizers:
   1. Patch cords organizers shall be steel and shall allow routing of patch cables from electronics to the patch panels.
   2. Single rack unit organizer shall be Hubbell #HS13C with cover. Refer to PCO-1 on detailed drawings.
   3. Approved equals, Ortronics and Great Lakes Case and Cabinet.

B. Tie Wraps:
   1. Tie wraps shall be used on exterior cables only.
   2. Tie wraps should not be used above the drop ceiling or in cable tray. The pathway shall support the cables without the use of extra tie wraps.
   3. Tie wraps shall never be used to support cables from building structure, electrical conduits, or lighting systems.
   4. Panduit No. PLT2S-C or equal standard tie wrap. For use in general locations that are not plenum rated.
   5. Panduit No. PLT2S-C702 or equal plenum rated tie wrap. Use only this type of tie wrap in plenum rated areas.
   6. Panduit No. PLT2H-L00 or equal ultraviolet rated outside plant tie wrap. Use only this type of tie wrap for outside uses.

C. Hook and Loop Wraps:
   1. Hook and Loop wraps shall be used on the cable ladder of the rack systems to bundle the cables as they pass along the cable ladder. Cables shall be bundled in groups of no more than 24 cables.

2. Hook and Loop wraps should not be used above the drop ceiling or in cable tray except in limited circumstances. The pathway shall support the cables without the use of extra tie wraps.
3. Wraps shall never be used to support cables from building structure, electrical conduits, or lighting systems.
4. Panduit HLT2I or equal.

D. Grounding and bonding of racks and cable ladder
1. Bond each rack and all parts of the cable ladder as 1 ground system.
2. Use Erico Eriflex woven copper grounding braids to attach racks and ladder.
3. Erico # 556700 or other lengths as required.

E. Rack Mounted shelf
1. Install shelves where equipment needs to be installed but is not rack mountable.
2. Identify equipment and depth of equipment and order shelf to match
3. Cantilevered shelves:
a. 1.75” tall rack mount shelf shall be Startech #Shelf-1U20-FIXED-V
b. 3.5” high, 14” depth with weight up to 50 lbs. Hubbell #MCCCS1

F. Blank Panels
1. Where there is equipment that needs to be mounted in the rack and needs to be vertically mounted install a blank panel.
2. Blank Panels shall be steel, black in color, Hubbell #MCCBPXXX where XXX is the height of the blank panel.

G. Vertical 19” rack mounting.
1. Provide and install a wall mount 19” rack kit
2. Shall support 19” rack mounting equipment being installed vertically.
3. Shall be deep enough to support 4 Rack units of 1.75” each
4. Shall be Hubbell #WB4 or equal.
5. Mount to plywood on wall or to block wall.

2.06 WALLFIELD EQUIPMENT

A. Plywood for Wallfields:
1. Plywood shall be American Plywood Association (APA), Grade A-C at minimum. Meaning that the “A” side is smooth and paintable, neat repairs are permissible. “C” side allows knotholes to 1 inch and limited splits are permitted. “A” side is used for mounting; “C” side is installed towards the wall.
2. Plywood shall be 3/4-inch-thick and shall come in 4 foot x 8 foot sheets with a quantity of sheets installed as per the detailed drawings.
3. All plywood used for wallfields shall be fire-retardant plywood and shall be stamped as such.
a. Shall have a Flame-spread rating of 25 or less,
4. Each piece of plywood with one coat of white paint. Paint all edges.
a. Do not paint over one of the Fireproof stamps on the plywood. Leave this so that the owner can identify that the plywood installed is fire-retardant.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Location of the communications infrastructure shall be finalized in the communications room prior to installation.

B. Locate all equipment to be installed, and make certain that space is available for maintenance and service during the life of the system.

C. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the communications room to the Engineer for approval prior to installation.

3.02 PREPARATION

A. Clean floor prior to installation of the communications racks.

B. Coordinate with all other Contractors and ensure that the locations of all cable tray and conduits are correct and will feed the rack system adequately.

3.03 INSTALLATION OF RACKS

A. All racks shall be square to the walls and installed in a straight line.
   1. Use only 3/8 inch bolts and connectors when constructing the racks and associated cable ladder.
   2. Install vertical cable ladder to the back of each vertical organizer of each rack. When multiple racks are side by side, 1 section of vertical cable ladder can serve both racks.
   3. Install the vertical cable ladder in the center of the vertical organizer. This allows cables to be routed down each side for use by both racks.
   4. Install horizontal sections of cable ladder along the top of the rack. Attach the horizontal sections to the vertical sections as well as the horizontal section of the next rack.
   5. Contact the Engineer prior to final placement of the racks.
   6. After approval of the placement of the racks, secure racks to the floor with anchors. Racks shall be secure after installation.
   7. Use 6 inch vertical organizers as spacers for racks. Attach racks to both sides of the vertical organizer, where multiple racks are required.
   8. Install unistrut “L” brackets to the bottom of the vertical cable ladder to secure the cable ladder to the floor.
   9. Each rack shall have an engraved phenolic label. The label shall be self-adhesive, black with white letters. The label shall be affixed to the front and top of the rack so it is visible while standing in front of the racks. Label shall correspond with the designated rack label as shown in the detailed drawings.
   10. Install woven ground braids between racks and cable ladder for eventual connection to the Telecommunications Ground Bar (TGB).
   11. Remove paint from rack where ground braid is attached to the rack or cable ladder. Use star washers for all ground connections.

3.04 INSTALLATION OF COMM ROOM EQUIPMENT

A. Patch cord organizers shall be installed between all patch panels and electronics.
   1. Horizontal organizers shall be used for routing fiber and copper patch cords between patch panels and electronics.
   2. Refer to Rack layouts on detailed drawings for quantity of organizers to provide.
   3. Organizers shall be installed side by side where multiple racks are installed.
   4. If changes in the rack layout are required, contact the Engineer and get changes approved prior to installation.

B. Tie wraps shall be used sparingly in the overall installation.
   1. Tie wraps shall not be used in the cable tray or above the drop ceiling for support of cables. All cables shall utilize J-hooks, conduits, cable ladder, or cable tray for support in the ceiling area.
   2. Tie wraps can be used to group cables on the cable ladder of the rack systems. Group cables in bundles of no more than 24 cables.
   3. Trim all tie wraps so that the cut edge is smooth.

C. Hook and Loop shall be used sparingly in the overall installation.
   1. Hook and Loop should not be used in the cable tray or above the drop ceiling for support of cables. All cables shall utilize J-hooks, conduits, cable ladder, or cable tray for support in the ceiling area.
   2. Hook and Loop can be used to group cables on the cable ladder of the rack systems. Group cables in bundles of no more than 24 cables.

D. Power strips shall be installed so that they do not interfere with the cable routing, or the installation of components into the rack.
   1. Modular plug for the outlet strip shall be installed at the bottom of the outlet strip.
   2. The outlet strip shall plug into 1 of 2 duplex receptacles installed at the bottom of the rack. Refer to the detailed drawings for receptacle locations.

3. Coil any extra cord from the outlet strip and tie wrap it to the bottom of the vertical cable ladder.
4. Securely attach the outlet strips to the back edge of the vertical cable ladder.
5. Electrical outlets are installed by others. Communications Contractor shall be responsible for connecting power strip to the outlets.

E. Shelves and blank panels
1. Install in the rack where required and/or where shown on the drawings.

3.05 WALLFIELD EQUIPMENT

A. Paint plywood with prior to installation on the wall.
1. Plywood shall be installed from 12 inches AFF to 7 feet above the floor or as noted on the drawings.
2. Mount plywood to the wall with screws attached to studs in the wall. Contractor is responsible for securely mounting the plywood to the wall.
3. Grade “A” side of the plywood shall be used for mounting all communications components.
4. If the plywood will cover an electrical receptacle, the Contractor shall cut the plywood to allow access to the receptacle.

END OF SECTION 28 1100

SECTION 28 1150 – COMMUNICATIONS GROUNDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes parts and equipment required for a communications grounding system installation.

1.02 SYSTEM DESCRIPTION

A. The grounding system from the ground bar in each communications room to the electrical ground shall be installed by the Electrical Contractor.
   1. This shall include connection of the ground bar in each communications room to the electrical ground. Shall also include:
      a. Connection of ground cables in the cable tray,
      b. Ground connections to electrical panels,
      c. Grounding of any riser conduits.

B. Telecommunications grounding systems shall be connected to the electrical ground at the Main Distribution panel.

1.03 INSTALL BASED ON STANDARDS INCLUDING:

A. NFPA 70-99,
B. National Electrical Code (latest edition adopted by AHJ)
C. TIA-607-C Generic Telecommunications Bonding and Grounding

1.04 COORDINATION

A. Coordinate ground connections to ground bar with Electrical Engineer and Contractor.
B. Coordinate the location of ground bars in the communications room with the Electrical Contractor prior to installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved equals for ground components are:
   1. Newton.
   2. Erico
   3. Hubbell

2.02 MATERIALS

A. Ground Bar shall be Hubbell #HBBB14210A or equal
B. Compression (crimp) type ground lugs for connection of ground cables shall be Burndy No. YCA series or equivalent.
   1. Use only manufacturer approved crimp tools with all crimp lugs.
C. Ground wire shall be No. 6 AWG for all ground connections from the equipment to the ground bar. Ground wire in plenum areas shall be bare with no insulation. All other ground wires shall have green insulation.
   1. Approved ground cable vendors are Southwire, The Okonite Company, and Pirelli or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Location of the ground bar shall be finalized in the communications room prior to installation.
B. Locate and note all equipment to be connected to the ground system. Routes for ground cables shall be planned prior to final location of the ground bar.
C. Identify location of racks, cabinets, and all electronic equipment. Connections from the ground bar to these are required for a complete ground system.

D. Connect the cable ladder to the ground bar in each communications room. Connect with a #6 AWG ground cable.

3.02 PREPARATION

A. Plan routes of all ground cables.

B. For components that are to be connected to the ground system, remove paint from the connecting point and attach to the ground cable with a star washer.

C. Ground cables shall be connected from the ground bar in each communications room with a No. 6 AWG ground cable. Items to be connected by the Communications contractor include, but are not limited to:

1. Each individual rack and cabinet
2. Cable ladder.
3. Cable tray.
4. Audio Video Systems
5. Protected entrance terminals (PET).
6. Splice cases.
7. Access Control Panels

3.03 INSTALLATION

A. Cabling Contractor shall Install the ground bar to the wallfield.

1. Coordinate location with other systems.
2. Work with Electrical contractor to have them connect the ground bar to the electrical service panel and building steel.

B. Ground connections shall meet all applicable codes, and shall be located such that they are accessible for maintenance.

1. All grounding conductors shall be continuous without splice.
2. Metal boxes, cabinets and fittings, or noncurrent carrying metal parts of other fixed equipment, if metallically connected to grounded cable armor or metal raceway, are considered to be grounded by such connection. If not connected, they shall be grounded in 1 of the following ways:
   a. By a grounding conductor run with circuit conductors, this conductor may be uninsulated. But if it is provided with an individual covering, the covering should be finished to show a green color.
   b. By a separate grounding conductor installed the same as grounding conductor for conduit and the like.
3. Metal raceways, cable armor, cable sheath, enclosures, frames, fittings, and other metal noncurrent carrying parts that are to serve as grounding conductors shall be effectively bonded where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them.
   a. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or be connected by means of fittings so designed as to make such removal unnecessary.
4. Continuity of metal raceway or metallic sheathed cable shall be assured throughout the system.
5. National electrical code shall be used as guide for grounding in hazardous areas.

C. Ground cables shall be installed in a neat and workmanlike manner.

1. All cables shall be supported or routed against a wall and attached to the wall. No free-floating cables between components will be allowed.
2. Fully support ground cable so that it does not sag between connections.
3. There shall be no sharp bends in the ground cables.

D. Terminate and connect all ground cables with crimp type connectors.

1. Use star washers on all connections of ground cables to ground bars and racks and equipment.

E. Ground systems shall be tested after installation to ensure proper installation and connectivity.

1. Test procedures shall be fully spelled out. They shall minimally include, the time and date of the test, name of tester, device used to test ground potential, and test results.
2. The Contractor shall provide test results, to the Engineer for final approval and sign off.
3. Ground connections shall be tested at each rack in each communications room. The system shall not be considered complete until the ground tests have been completed and acceptable results are provided.

END OF SECTION 28 1150

SECTION 28 1500 – FIBER CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes parts and equipment required for installation, termination and testing of a fiber optic cable backbone.

1.02 SYSTEM DESCRIPTION

A. The fiber optic backbone shall include all components of the system from the patch panels to the backbone fiber and everything in between.

1.03 CONTRACTOR

A. Contractor company shall have a minimum of 3 years' experience installing and testing fiber optic cabling systems.
   1. Unless otherwise specified, multimode and single mode fiber cable must meet the transmission performance parameters as specified in ANSI/TIA/EIA-568-B.3.
   2. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years' experience in producing field test equipment. Manufacturers must be ISO 9001 certified.
   3. Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA/EIA-526-14A, "Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant," and TIA/EIA-526-7 Method A, "Measurement of Optical Power Loss of Installed Single Mode Fiber Cable Plant, Insertion Loss Using An Optical Power Meter."
   4. Traces and records shall be provided to the Engineer and Owner in hard (paper) and soft (disk) copy.

1.04 COORDINATION

A. Coordinate work under provisions in Division 1 of these specifications.
B. All fiber cables shall be coordinated with the installation of the telecommunications raceways.
C. Coordinate location of the spare coiled fiber cables with Engineer prior to installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved vendors for fiber cable are:
   1. Optical Cable Corporation.
   2. General Cable.
   3. Berk-Tek.
   4. Corning
   5. Hubbell

B. Approved vendors for fiber termination equipment are:
   1. Hubbell.
   2. Panduit.
   3. Optical Cable Corporation
   4. Corning

2.02 FIBER CABLE

A. All fiber cables shall be of tight buffered construction. A tight buffered optical fiber shall consist of a central glass optical fiber surrounded by a primary polymer buffer and an optional tight fitting secondary buffer.
   1. The outer jacket of each fiber strand shall be colored according to the fiber color code in TIA 598-B.
   2. Individual multimode fiber strands shall be 50/125μm for the core/cladding measurements.

3. Individual singlemode fiber strands shall be 9/125μm for the core/cladding measurements.
4. All fiber strands shall be surrounded by synthetic yarn for added strength and crush resistance.
5. All fiber installed in plenum rated areas shall be UL listed OFNP.
6. The outer jacket of the cable shall be surface printed with the manufacturer's identification and required UL markings.
7. All fibers shall be subjected to a minimum fireproof stress of 0.7 GPa (100 kpsi).
8. The minimum bend radius of the cable under full rated tensile load shall be no larger than 15 times the outside diameter of the cable and no more than 10 times the outside diameter of the cable with no load on the cable.
9. Optical and mechanical performance shall not be degraded and the cable shall not be damaged in any way by immersion in ground water.
10. The fiber optic cable shall meet or exceed the requirements of this specification when measured in accordance with the methods of the individual requirements or the following methods as defined in EIA-STD-RS-455.
    a. Fiber dimensions.
    b. Attenuation.
    c. Bandwidth.
    d. Numerical aperture.
    e. Fiber proof test.
    f. Cable bending.
    g. Tensile load
    h. Impact resistance.
    i. Crush resistance.
    j. Attenuation vs. temperature.
11. Manufacturer shall provide ISO 9001 certification.
12. The cable shall withstand an impact force 1500 times per ANSI/TIA/EIA-RS-455 (FOTP-25A).
13. The cable shall withstand compression load of 1800 N/cm per ANSI/TIA/EIA-RS-455 (FOTP-41A).
14. Fiber shall be indoor/outdoor rated based on the areas in which the fibers will be installed. Do not install riser rated fiber through a plenum rated area unless the fiber is inside an EMT conduit.

B. Indoor and outdoor rated, Plenum rated fiber.
1. The multi-fiber sub-cables shall consist of tight buffered optical fibers surrounded by a synthetic yarn strength member and a color-coded flame retardant elastomeric polymer jacket. The strength member shall be composed of individually and precisely tensioned elements such that tensile loads are equally shared by each element.
2. Single-mode indoor/outdoor, plenum rated fiber cable
    a. Wavelength: 1310/1550nm
    b. Industry Standard: ITU-T G.652.D
    c. 1 Gigabit Ethernet Distance: 5 km
    d. 10 Gigabit Ethernet Distance: 10 km
    e. Max Attenuation: .5/.5 dB/km
    f. Singlemode, indoor/outdoor, Plenum rated Yellow jacket: OCC # DZ024TSLA9YP

2.03 RACK MOUNT FIBER PATCH PANELS

A. 12-36 port, rack mount fiber patch panels.
1. Rack mount fiber patch panels shall be modular in design. Mounting brackets shall be provided for 12 pack adapters. Adapter packs shall sit horizontally in the panel.
2. Panels shall mount into standard 19-inch relay racks.
3. Panels shall be no more than 1-3/4 inch or 1 rack unit high.

4. Provide splice tray and splice shelf or splice cassettes for termination of all fiber strands.
5. Fiber panel shall be Hubbell #FPR3SP or equal
   a. Equip with Splice trays as required. Hubbell #Stray12F or Stray24F
   b. Equip with Label Kit, Hubbell #LBLKTFCR1U12
6. Provide Hubbell Fiber Splice cassettes or pigtails and panels for splicing and termination of all fiber strands. See Below:

2.04 FIBER PIGTAIL SPLICE CONNECTORS

A. All fiber cables shall be terminated with spliced pigtails matching the fiber cable that was installed.

B. LC Style Connectors pigtails
1. Singlemode connectors shall be LC style.
2. Provide 1-meter, pre-connectorized pigtails for fusion splicing to each fiber strand.
3. Singlemode Pigtails shall be Yellow in color
4. All spicing shall be Fusion splicing. Mechanical splicing is not allowed.
5. Match the size of the glass in the pigtail to the size of the glass in the fiber.
6. Work with fiber cable manufacturer on specifying pigtails that exactly match the fiber cable being terminated.
7. Singlemode LC terminated single strand, fiber pigtails shall be Hubbell #FHPBKR12LC6S or equal.

2.05 FIBER PATCH PANEL ACCESSORIES

A. Fiber stowage ring
1. Install a ring on the wall near the racks for stowage of 30’ of spare fiber or as noted on the drawings.
2. Fiber stowage ring shall be Leviton # 48900-OFR.
3. Label the fiber at the stowage ring with both termination points. Install label Panduit PST-FO or equal

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine all pathways prior to installation of fiber cable.

B. Identify location of racks, and position of fiber patch panels prior to fiber installation.

C. Inspect fiber cable prior to installation for damage during shipping. The Contractor shall be responsible for all damaged or nonfunctional fiber cables. If any strands of a fiber cable are not working, the Engineer has the right to order the complete replacement of the entire fiber cable.

3.02 PREPARATION

A. Contractor shall designate the location of the spare coil of fiber at each end of the run prior to installation.

3.03 INSTALLATION

A. Installation of fiber cable shall be by a trained installer.
1. All fiber, if not installed inside cable tray, shall be attached to the building structure with conduit clamps or supports a minimum of every 5 feet.
2. Fiber shall be continuous from end to end, no splices are allowed unless specifically noted.
3. At each termination point of the fiber, the Contractor shall provide a service coil consisting of a minimum of 30 feet of fiber cable.
4. Contractor shall adhere to all manufacturer’s recommended pull tensions during installation.
5. As part of the as-built drawings, provide the actual footage of each fiber cable installed. Mark this on the drawings.

6. Any fiber strands that do not pass a sufficient signal light signal will be identified as noncompliant, and the Engineer has the right to order the complete replacement of the fiber cable by the Contractor.
7. Where fiber cable passes vertically through a building, the fiber cable shall be supported against the wall or from the ceiling a minimum of every 5 feet.
8. Do not exceed recommended bend radius of fiber cable during or after installation.

B. Fiber patch panels shall be located at the top of the relay rack or cabinet at which they are installed. Install on wall or inside cabinet where shown for wall mounted fiber panels.
1. Provide patch panels as described on the contract drawings or additional panels as required to terminate all fiber strands of all fiber cables.
2. Install fiber panels in the top of the rack where possible
3. If a splice shelf is required for splicing of fibers, install the shelf directly below the associated patch panel.
   a. Provide and install splice panels as required for splicing of all pigtails to terminate the fiber strands.
4. Route fiber cable into side of the panel. Provide a wrap-around label at this location to identify the fiber cable as it enters the fiber panel.
   a. Label the fiber cable just outside of the fiber panel with a yellow fiber optic cable label, Panduit No. PST-FO.
5. The sheath of the fiber cable shall extend to the side of the panel. Individual fibers or subgroups shall not be seen outside of the panel, except for the single mode bundles.
6. Fibers shall be installed in the adapter packs in color code order. For vertical mounted 12 pack adapters, top to bottom then left to right. In panels where the couplers are horizontally mounted, left to right for each 12 pack, then top to bottom. Contact the Engineer with any questions.
7. All individual fiber strands shall be neatly installed in the back of the panel after termination. Provide a minimum of 4 feet of spare fiber in the back of each panel. This spare shall be coiled in a Figure 8.
8. Secure the fiber to the entrance of the patch panel with tie wraps.
9. After installation and termination of the fiber cable, install labels on the patch panel showing what strand each connector is connected to, and where the overall fiber cable is terminated at the other end.
10. Attach a self-adhesive clear plastic sleeve to the inside of the Plexiglass cover of the rack mount panel. Slide in a laser printed label showing all information about the fiber cable.
11. Label door of wall mount panels to detail the fiber cable type, strand count and termination locations

C. Fiber cables shall be terminated with fusion spliced Pigtails.
1. All Singlemode and multimode fiber cables shall be terminated with a pre-terminated fiber optic pigtail which matches the diameter and type of fiber being installed.
2. Fusion splice all pigtails to the fiber cables. Terminate each strand of the fiber cable.
3. Each strand shall be thoroughly cleaned and all coverings shall be removed prior to splicing
4. To cleave the fiber, use the method and equipment recommended by the manufacturer of the fusion splicer that will be used.
5. Fibers shall be properly aligned prior to splicing.
6. The splicer used shall be able to inject light directly into the fiber just after it is spliced, and provide an estimate of the loss through the splice.
7. After splicing, a heat shrink tube with a rigid skeleton shall be used to protect the splice. Coordinate this heat shrink tube with the splice tray to be installed in the splice shelf. Heat shrink tubes shall fit into the grooves in the splice tray.
8. Loss through the splice shall be no more than .15dB.
9. Fiber pigtails shall be labeled with a self-laminating, laser printed, wrap around label at the connector. The label shall detail the strand count of the fiber cable, the buildings

and rooms in which the fiber is terminated and the color and strand number the pigtail is spliced to.

24MM/12SM
WRT#234-OLS #021
Brown Fiber # 16

END OF SECTION 28 1500

SECTION 28 1600 – CAT-6 CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes parts and equipment required for installation, termination, and testing of user communications cables.

1.02 SYSTEM DESCRIPTION

A. The horizontal cabling consists of all systems from the user faceplate, to the patch panel in the communications room, and all connections in between.

B. Products and installation detailed in this section shall comply with all applicable requirements.

1. ANSI/TIA-568-C.0, "*Generic Telecommunications* Cabling *for Customer Premises*",
2. ANSI/TIA-568-C.1, "*Commercial Building Telecommunications Cabling Standard*",
3. ANSI/TIA-568-C.2, "*Balanced Twisted-Pair Telecommunication Cabling and Components Standard*", ANSI/TIA-568-C.3, "*Optical Fiber Cabling Components Standard*",
4. ANSI/TIA-568-C.4, "*Broadband Coaxial Cabling and Components Standard*",
5. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
6. IA-606-B: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings including all Updates and Addenda.
7. TIA-607-C: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
8. IEEE 802.3af PoE • Ratified in 2003 • 15.4W at the PSE, with min of 12.95W available to the PD
9. IEEE 802.3at PoE+ • Ratified in 2009 • 34.2W at the PSE, with min of 25.5W available to the PD
10. IEEE 802.3af PoE • Ratified in 2003 • 15.4W at the PSE, with min of 12.95W available to the PD
11. IEEE 802.3at PoE+ • Ratified in 2009 • 34.2W at the PSE, with min of 25.5W available to the PD
12. IEEE 802.3bt -Amendment 2. Ratified in 2018 PoE standards powering all 4 pairs:

1.03 COORDINATION

A. All cables shall be coordinated with the installation of the telecommunications raceways.

B. Coordinate all user cables with the furniture to be installed in the building. Make any adjustments prior to cable being installed.

C. Contractor shall walk the site during construction and shall verify all raceways are being installed as required to install the user data cables. Walk the site prior to drywall being installed or floors being installed when Floor boxes are being installed.

1.04 STANDARDS

A. Cabling shall be installed in accordance with NEC code for grouping/bundling of cables in relation to Type 3 and Type 4 PoE

B. Install as per NEC 840.160 in reference to bundling cables:

AWG	Numberof 4-Pair Cables in a Bundle																				
	1			2-7			8-19			20-37			38-61			62-91			92-192		
	Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating			Temp Rating		
	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	0.5	0.6	0.7	0.4	0.5	0.6	0.4	0.5	0.6	NA	NA	NA
24	2.0	2.0	2.0	1.0	1.4	1.6	0.8	1.0	1.1	0.6	0.7	0.9	0.5	0.6	0.7	0.4	0.5	0.6	0.3	0.4	0.5
23	2.5	2.5	2.5	1.2	1.5	1.7	0.8	1.1	1.2	0.6	0.8	0.9	0.5	0.7	0.8	0.5	0.7	0.8	0.4	0.5	0.6
22	3.0	3.0	3.0	1.4	1.8	2.1	1.0	1.2	1.4	0.7	0.9	1.1	0.6	0.8	0.9	0.6	0.7	0.8	0.5	0.6	0.7

C. Cables shall be installed with no more than 24 cables in a single J-hook. Install additional J-hooks as required.
D. If cables are to be bundled/grouped in larger bundles then the cable shall be LP listed per UL.
E. All cables shall be no smaller than 23 AWG.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved vendors for copper user cables are:
1. Panduit
2. Hubbell
3. Belden
4. CommScope
5. Mohawk
6. Superior Essex
7. Paige

B. Approved vendors for CAT-6 termination equipment are:
1. Hubbell.
2. Panduit (Net Key not allowed)
3. Belden
4. CommScope

2.02 CAT-6 CABLING

A. All UTP user/cabling installed shall be CAT-6 rated or above.
1. Category 6 cabling shall consist of 4 pairs of unshielded twisted pair, 23 AWG cables.
2. All CAT-6 cables shall be installed in cable tray or supported by J-Hooks.
3. Individual pair shall be marked in the standard 4 pair color code of blue/blue-white, orange/orange-white, green/green-white, and brown/brown-white.
4. Each cable shall be marked sequentially with the footage of the cable. Each cable shall also be marked with the manufacturer of the cable and the type of cable installed or the cable part number.
5. Cable and all connectors and patch panels shall meet or exceed the following electrical and physical requirements:

DC RESISTANCE (max)	23 AWG
Ohms/100m @ 20°C	9.38ohms
DC RESISTANCE UNBALANCED (max)	
Individual Pair %	5%

CHARACTERISTIC IMPEDANCE	
Frequency (f)	Ohms
1-500 Mhz	100 ±15

DELAY SKEW (max)

ns/100m	45

NOMINAL VELOCITY OF PROPAGATION (NVP)	
% Speed of light	72

INPUT IMPEDANCE	
Frequency (f)	Ohms
1.0-100 Mhz	100 ±15
100-350 Mhz	100 ±20
350-500 Mhz	100 ±25

REFERENCE ELECTRICAL CHARACTERISTICS

FREQ (MHz)	INSERTION LOSS (dB/100m)		NEXT (dB/100m)		ACR (dB/100m)	PS-NEXT (dB/100m)		PS-ACR (dB/100m)	ELFEXT (dB/100m)	PS-ELFEXT (dB/100m)	RL (dB)
	avg	max	avg	min	min	avg	min	min	min	min	min
.772	1.7	1.8	82	76.0	74.2	77	74.0	72.2	–	–	–
1.0	1.9	2.0	80	74.3	72.3	75	72.3	70.3	67.8	64.8	20.0
4.0	3.6	3.8	71	65.3	61.5	66	63.3	59.5	55.8	52.8	23.0
8.0	5.1	5.3	67	60.8	55.5	62	58.8	53.5	49.7	46.7	24.5
10.0	5.7	6.0	65	59.3	53.3	60	57.3	51.3	47.8	44.8	25.0
16.0	7.3	7.6	62	56.2	48.6	57	54.2	46.6	43.7	40.7	25.0
20.0	8.1	8.5	61	54.8	46.3	56	52.8	44.3	41.8	38.8	25.0
25.0	9.1	9.5	59	53.3	43.8	54	51.3	41.8	39.8	36.8	24.3
31.25	10.2	10.7	58	51.9	41.2	53	49.9	39.2	37.9	34.9	23.6
62.5	14.8	15.4	53	47.4	32.0	48	45.4	30.0	31.9	28.9	21.5
100.0	19.0	19.8	50	44.3	24.5	45	42.3	22.5	27.8	24.8	20.1
155.0	24.2	25.2	47	41.4	16.3	42	39.4	14.3	24.0	21.0	18.8
200.0	27.8	29.0	46	39.8	10.8	41	37.8	8.8	21.8	18.8	18.0
250.0	31.5	32.8	44	38.3	5.5	39	36.3	3.5	19.8	16.8	17.3
300.0	35.0	36.4	43	37.1	0.7	38	35.1	--	18.3	15.3	16.8
350.0	38.2	39.8	42	36.1	--	37	34.1	--	16.9	13.9	16.3
400.0	41.3	43.0	41	35.3	--	36	33.3	--	15.8	12.8	15.9
500.0	47.0	48.9	40	33.8	--	35	31.8	--	13.8	10.8	15.2
550.0	49.7	51.8	39	33.2	--	34	31.2	--	13.0	10.0	14.9

6. All cables installed above a drop ceiling or fixed ceiling shall be Plenum Rated
7. CAT-6, 4 pair cabling shall be plenum rated unless specifically noted.

Cable Use	Manufacturer	Color	Part number	Rating
Data Cabling	Mohawk	Blue	M58281	Plenum
Security Camera	Mohawk	Green	M58286	Plenum
IP/POE locks at doors	Mohawk	White	M58280	Plenum
Audio/ video	Mohawk	Black	M58289	Plenum
Backbone	Mohawk	Purple	M58290	Plenum
USB	Mohawk	Orange	M58288	Plenum
Paging -MDOC	Mohawk	Brown	M58756	Plenum
Underground	Mohawk	Black	M58772	Underground
Shielded Underground Rated	Belden	Black	OSPF6F	Underground / Shielded

8. Ensure that cable passes all CAT-6 tests after installation.

2.03 CAT-6A CABLE -SMALL DIAMETER

A. Unshielded Twisted Pair (UTP) CAT-6A cable

B. Shall meet standards:

1. ANSI/TIA-568-C.2 AND ISO/IEC 11801:2002 CATEGORY 6A ELECTRICAL CHARACTERISTICS.

C. Cable shall consist of:
1. 23 AWG solid bare copper insulated conductors, assembled into 4 pairs cabled together with a assembly: flexweb core separator
2. Jacket shall include footage markers
   a. Outer diameter shall be .25”
3. The cable shall be plenum rated for use in air handling ducts and spaces in accordance with article 800 of the National electrical code (NEC).
4. Shall be US Listed C(UL)US OR C(ETL)US TYPE CMP UL OR ETL VERIFIED CAT 6A
5. Supported Applications
   a. IEEE 802.3 10BASE-T (ETHERNET),
   b. 100BASE-T (FAST ETHERNET),
   c. 1000BASE-T (GIGABIT ETHERNET),
   d. ANSI.X3.263 FDDI
   e. TP-PMD, IEEE 802.5 4 AND 16 Mbps TOKEN RING,
   f. 550 MHz BROADBAND
   g. VIDEO AND ATM UP TO 4.8 Gbps.
   h. IEEE 802.3an 10gbase-t (10 gigabit Ethernet),
   i. Access points and PoE / PoE+.

D. Physical Characteristics
1. Bending radius: 1” (25 mm) min)
2. Pulling tension: 25 lbf (110 n) max
3. Operating temp.: -20°c to +75°c (-4°f to +194°f)
4. Storage temp.: -20°c to +75°c (-4°f to +194°f)
5. Installation temp.: 0°c to +50°c (+41°f to +122°f)

E. Shall meet or exceed following testing parameters.

REFERENCE ELECTRICAL CHARACTERISTICS

FREQ (MHz)	INSERTION LOSS (dB/100m)	NEXT (dB/100m)	PS NEXT (dB/100m)	ACRF (dB/100m)	PS ACRF (dB/100m)	RETURN LOSS (dB)	PROP. DELAY (ns/100m)	ALIEN CROSSTALK	
								PS ANEXT (dB/100m)	PS AACRF (dB/100m)
	max	min	min	min	min	min	max	min	min
1.0	2.1	74.3	72.3	67.8	64.8	20.0	575.0	67.0	67.0
4.0	3.8	65.3	63.3	55.8	52.8	23.0	557.0	67.0	66.2
8.0	5.3	60.8	58.8	49.7	46.7	24.5	551.7	67.0	60.1
10.0	5.9	59.3	57.3	47.8	44.8	25.0	550.4	67.0	58.2
16.0	7.5	56.2	54.2	43.7	40.7	25.0	548.0	67.0	54.1
20.0	8.4	54.8	52.8	41.8	38.8	25.0	547.0	67.0	52.2
25.0	9.4	53.3	51.3	39.8	36.8	24.3	546.2	67.0	50.2
31.25	10.5	51.9	49.9	37.9	34.9	23.6	545.4	67.0	48.3
62.5	15.0	47.4	45.4	31.9	28.9	21.5	543.6	65.6	42.3
100.0	19.1	44.3	42.3	27.8	24.8	20.1	542.6	62.5	38.2
155.0	24.1	41.4	39.4	24.0	21.0	18.8	542.1	59.6	34.4
200.0	27.6	39.8	37.8	21.8	18.8	18.0	541.5	58.0	32.2
250.0	31.1	38.3	36.3	19.8	16.8	17.3	541.3	56.5	30.2
300.0	34.3	37.1	35.1	18.3	15.3	16.8	541.1	55.3	28.7
350.0	37.2	36.1	34.1	16.9	13.9	16.3	540.9	54.3	27.3
400.0	40.1	35.3	33.3	15.8	12.8	15.9	540.8	53.5	26.2
500.0	45.3	33.8	31.8	13.8	10.8	15.2	540.6	52.0	24.2

SWEEP TESTED TO 500 MHz

F. CAT-6A, 4 pair cabling shall be plenum rated unless specifically noted.

Cable Use		Manufacturer	Color	Part number	Rating
Wireless AP		Mohawk	Yellow	M59230	Plenum

G. Ensure that cable passes all CAT-6A tests after installation.

2.04 LONG DISTANCE UTP CABLE.

A. At locations inside and outside a building where the CAT-6 cable will be longer than 300ft the contractor shall supply and install an “Extended Distance” UTP, 4-pair Ethernet Cable.

B. Cable must be constructed with 4-pair copper conductors and can be unshielded or shielded with designated jacketing compounds to meet the installed environments — indoor or outdoor —as specified in the accompanying documentation. Performance requirements must meet or exceed the values listed on the data sheets in Section 2.4

C. Cable shall meet the following requirements:
1. Shall extend 1 Gig Ethernet up to 200 Meters
2. Shall provide for Type 4 PoE up to 200 Meters
3. IEEE 802.3bt Compliant for Type 1 to Type 8 PoE
4. Shall meet 90 Degree temperature rise requirements
5. UL listed
6. 22AWG solid copper conductors
7. Shall be available in Riser, Plenum and outdoor ratings
8. Use with CAT-6 terminations

D. Shall be Superior Essex PowerWise or Paige GameChanger

E. Paige Game Changer part numbers:
1. Unshielded Twisted Pair, Plenum Rated (CMP), # 250300303 -Yellow in Color
2. Unshielded Twisted Pair, Plenum Rated (CMP), # 258300309-Green in Color
3. Unshielded Twisted Pair, Plenum Rated (CMP), # 258300310 -White in Color
4. Unshielded Twisted Pair, Plenum Rated (CMP), # 258300336 -Blue in Color

F. Superior Essex Powerwise part numbers:
1. 10Gig, Plenum rated, extended distance to 333 feet at 10 Gig and PoE++ (Type 4)
   a. PW6H-H72-XB where X is the color.
2. 1Gig, Plenum Rated, extended distance to 525’ at 1 Gig and PoE (Type 1 and 2). 460’ at PoE Type 3 and 4.
   a. PW52-H46-X8 where X is the color.
3. ****X Denotes Color
4. Color table:

2	3	4

2.05 UTP JACKS

A. 8-position modular jacks for termination at user and at the patch panel. Match cable color except where noted on drawings.
1. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760 inches x .580 inches).
2. Jack housings shall be high impact 94 V-0 rated thermoplastic.
3. Jack housings shall fully encase and protect printed circuit boards and IDC fields.
4. Modular jack contacts shall accept a minimum of 1000 mating cycles with 5.0 milliohm (maximum) increase over initial with the use of an FCC compliant plug.
5. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.
6. Modular jack contacts shall be constructed of beryllium copper for maximum spring force and resilience.
7. Contact plating shall be a minimum of 50 micro inches of hard gold in the contact area over 50 micro inches of nickel.
8. Jack termination shall follow the industry standard 110 IDC.
9. Jacks shall have a designation indicating CAT-6 or CAT-6A as required.
10. Jacks shall utilize a paired punch down sequence. Cable pair twist shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
11. Jacks shall terminate 22-26 AWG stranded or solid conductors.
12. Jacks shall terminate insulated conductors with outside diameters up to .050 inches.

13. Jacks shall be compatible with single conductor, 110 impact termination tools.
14. Jacks shall include translucent wire retention stuffer cap that holds terminated wires in place and allows the conductors to be visually inspected in the IDC housing.
15. Jacks shall be compatible with EIA/TIA 606A color code labeling.
16. Jacks shall accept snap on icons for identification or designation of applications.
17. Jacks shall be marked for T568A and T568B wiring schemes. TIA 568B wiring shall be used in all terminations throughout the communications system.
18. All CAT-6 modular jacks and panels shall meet or exceed the following transmission characteristics:
    a. Jacks shall be designed for 100 Ohm UTP cable termination.
    b. Jacks shall be UL verified for TIA/EIA Category 6 electrical performance.
    c. Jacks shall be UL listed 1863 and CSA certified.
    d. Jacks shall be manufactured by an ISO 9002 registered manufacturer.
19. CAT-6, 8-pin modular jacks shall be:
    a. Data Jacks shall be Hubbell # HXJ6OW or equal. Office White.
    b. Data Jacks for Security Cameras shall be Hubbell #HXJ6GN-Green
    c. Data jacks for Wireless Access Points shall be Hubbell #HXJ6Y-Yellow
    d. Data jacks for backbone connectivity shall be Hubbell #HXJ6P-Purple
    e. Data Jacks for IP/POE locks at doors shall be Hubbell #HXJ6W -White
    f. Data Jacks for Audio and Video connections shall be:
        1) Hubbell #HXJ6BK-Black
    g. Data Jacks for USB connections shall be Hubbell #HXJ6OR-Orange
    h. Data Jacks for Paging Systems shall be Hubbell #HXJ6BN-Brown
20. CAT-6A, 8-pin modular jacks shall be:
    a. Data jacks for Wireless Access Points shall be Hubbell #HJU6AY-Yellow

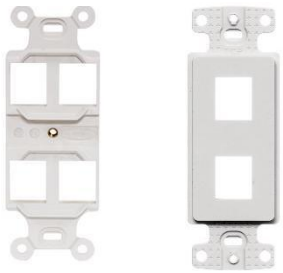
2.06 FACEPLATES

A. Modular Standard flush mount faceplates shall support all the jacks and connectors required.
1. Faceplates shall be UL listed and CSA certified.
2. Faceplates shall be constructed of high impact thermoplastic or stainless steel. See drawings for specific requirements.
3. Faceplates shall be 2-3/4 inches wide x 4-1/2 inches high (69.8 mm x 114.3 mm) for single gang, and 4-1/2 inches x 4-1/2 inches (114.3 x 114.3 mm) for double gang.
4. Faceplates shall be available to mount 1, 2, 3, 4, or 6 jacks in a single gang and up to 12 jacks in a double gang configuration.
5. Faceplates shall provide for TIA/EIA 606 compliant station labeling.
6. Faceplates shall have plastic covers over the mounting screws that can be replaced with a clear plastic window over a printable paper insert.
7. Each plate shall be fully configured with modular inserts. There shall be no open spaces in the faceplate.
8. Match the color of the modular inserts to the color of the faceplate. All faceplates and inserts shall be office white unless otherwise noted.
9. Single gang plastic faceplate shall be Hubbell # IMF1OW.
10. Double gang plastic plate shall be Hubbell # IMF2OW.
11. Sing Gang, stainless steel, modular faceplates shall be Hubbell #IMSS1
12. Double Gang, stainless steel, modular faceplates shall be Hubbell #IMSS2
13. Each single gang plate has 3 faceplate units (FPU's) available to install inserts. Double gang plates have 2 sides, each with 3 FPU's.
14. Equip plates with the following parts as directed on the construction drawings.

FPU	ITEM	PART NUMBER
	Blank Jack	SFB10
.5	Blank	IMB05OW
1	Blank	IMB1OW

1.5	Blank	IMB15OW
1	1 Port Flat	IM1K1OW
1	2 Port Flat	IM2K1OW
1.5	1 Port Angled	IM1KA15OW
1.5	2 Port Angled	IM2KA15OW

B. Integrated furniture outlets, GFI style inserts and plates, and standard 106 style inserts and plates.
   1. These may be required at some surface raceway location. Field verify prior to ordering.
   2. The Contractors shall identify which type of outlet or frame is required at each location throughout the system.
   3. Match the outlet with the faceplate required.
   4. GFI, more commonly referred to as style line inserts, are rectangular and fit in a rectangular plate used for GFI receptacles.
   5. 106 style inserts are configured to fit in a common duplex electrical receptacle faceplate. The inserts hold 2 or 4 modular jacks.
   6. Each type of modular furniture has certain requirements for its voice and data modules. The Contractor shall coordinate with the furniture installer and provide the correct faceplate and outlets to match the color and style of the furniture.
   7. For all connections that do not have a faceplate with a location for a laser printed paper label, the Contractor shall provide an engraved lamacoid label detailing the location number of each cable.
   8. GFI/Style line Stainless Steel Plates shall be:
      a. Single Gang, Hubbell #SS26
      b. Double Gang, Hubbell #SS262
      c. Three Gang, Hubbell #SS263
   9. GFI/Style line Plastic plates without a Label Field shall be:
      a. Single Gang, Hubbell #NPJ26GY-Gray
      b. Double Gang, Hubbell # NPJ262GY-Gray
      c. Three Gang, Hubbell # NPJ263GY-Gray
   10. GFI/Style line Plastic Plates with Label Field shall be:
      a. Single-Gang, Hubbell #IFP126OW -Office White
      b. Double-Gang, Hubbell #IMFP2OW -Office White
   11. GFI/Style Line Inserts shall be:
      a. Provide an insert to support all Modular jacks that are to be installed.
      b. One Port Hubbell #NS611W
      c. Two port, Hubbell # NS612W
      d. Three port, Hubbell # NS613W,
      e. Four port, Hubbell # NS614W
      f. Six port, Hubbell # NS616W.
      g. Blank, Hubbell #NS620W
   12. 106 style inserts shall be:
      a. Two port, Hubbell #BR106W
      b. Four Port, Hubbell #Q106W
   13. Examples



a. 106 Style GFI/Style-Line

C. Brush opening plate
1. Where routing AV cables through an open backbox the contractor shall install a “brush” plate that covers the backbox and allows cable to pass thru
2. Provide a single or double gang cover plate with GFI openings.
3. Single-gang plates shall be Hubbell #SS26 with Leviton #41078-DBW, White in color or equal
4. Double-gang plates shall be Hubbell #SS262 with Two (2), Leviton #41078-DBW, White in color or equal

D. Wall mount phone plates shall be stainless steel.
1. Each plate shall be equipped with a CAT-6, 8 port modular jack.
2. Each plate shall be equipped with stainless steel studs for mounting a wall mount telephone to the plate.
3. Single gang wall mount phone plate shall be Hubbell #SP6F or #SP6R base on telephone type. Coordinate with owner prior to ordering.

2.07 SURFACE MOUNT BOXES

A. Provide surface mount boxes for termination of cables as shown on the drawings.
1. Install a surface mount box at location for termination of the modular jacks.
2. One port surface box shall be Hubbell #HSB1OW.
3. Two port surface box shall be Hubbell #HSB2OW
4. Four Port Surface box shall be Hubbell #HSB4OW
5. For all plenum rated ceilings and areas the contract shall provide plenum rated surface mount boxes. For Hubbell products. Add a “P” to the end of the part number.

2.08 CABLE SUPPORTS

A. All cables shall be supported in the ceiling a minimum of every 5 feet. Support can be provided by installing cable inside cable tray or conduit, or by installing J-hooks or bridle rings with saddles every 5 feet.
1. J-hooks
a. Hooks shall provide a smooth steel or plenum rated plastic, support for cables as they route through the ceiling. Shall be rated for the ceiling area where they are being installed. Verify any plenum rated areas and only install plenum rated supports
1) Metal J-hooks supports shall have a galvanized finish.





2)
3) Shall be UL listed, ultimate static load limit 50 pounds rated to support Category 5e and higher cables, and optical fiber cables.
b. If required, assemble to manufacturer recommended specialty fasteners, including beam clips and flange clips.
c. Acceptable products shall be:
1) CADDY #CAT HP series with retainer hooks or Panduit J-Pro series supports
1) Minimum square inch size of support for cables on the J-hook shall be 2.25”
2) Caddy HP21xxxx series or

3) Panduit JP2Wxxxx series or equal

d. Provide with interfaces and clamps required to support J-Hooks from the building structure.

2. Bridle Rings

a. Bridle Rings with saddles shall provide a smooth plenum rated plastic, support for cables as they route through the ceiling. Shall be rated for the ceiling area where they are being installed. Verify any plenum rated areas and only install plenum rated supports

1) Bridle ring supports shall have a zinc plated finish.

2) Bridle ring saddles shall be yellow in color and plenum rated. Shall meet CAT-6 and CAT-6A cable support standards.



3)

b. If required, assemble to manufacturer recommended specialty fasteners, including beam clips and flange clips.

c. Acceptable products shall be:

1) 1.5” diameter, Minerallac 646RS series or equal

2) 2” diameter, Minerallac 648RS series or equal

d. Provide with interfaces and clamps required to support Rings from the building structure.

B. Ceiling supports

1. J-Hooks and Rings shall be supported from the building structure. This includes connections to the walls, concrete ceiling, building steel and contractor installed vertical supports that are attached to the building structure.

2. Contractor can install threaded rod or other supports such as Unistrut or Drop ceiling tiles to support the J-hooks and subsequently the cables.

3. Supports shall be installed every 5 feet and shall be installed to keep cables from resting on pipes, ducts, structural steel, lights, ceiling grid, electrical conduits and any other structure that cable could possibly rest against.

4. Provide threaded rod and associated hardware required to support all J-Hooks

a. Paint threaded rod Yellow prior to installation

5. Above Drop ceilings, or accessible hard ceilings, the contractor can install support wire to support the J-Hooks.

a. Drop ceiling support wire shall be 12 AWG minimum

b. Attach to building structure.

c. Attach to drop ceiling grid.



d.
e. Paint support wire Yellow prior to installation.
f. Provide associated hardware required to support all J-Hooks.



g.
6. No more than 24 data cables in each J-hook. No more than 32 able sin each 2” Bridle Ring. Provide additional hooks and rings as required to support all cables.

2.09 RACK MOUNTED PATCH PANELS

A. Patch panels for termination of UTP cabling shall be provided to terminate all cables installed in the building.
B. All patch panels shall be installed into 19” racks and/or cabinets as shown on the drawings.
C. Provide panels to terminate all cables even if the panels are not specifically shown on the rack layout drawings.
   1. Provide the quantity and color of Modular jacks to match the color and quantity of all cables installed.
D. Panels shall be steel and shall allow mounting of all CAT-6 an CAT-6A jacks. Panels shall be blank panels that accept all modular jacks.
E. CAT-6 patch panels for mounting in a 19-inch rack or cabinet. Shall be;
   1. Panels shall be made of black anodized aluminum, in 24 and 48 port configurations.
   2. Panels shall accommodate 24 ports for each rack mount space or "U" (1U = 44.5 mm [1.75 inch]).
   3. Panels shall be manufactured with a rolled edge at the top and bottom for stiffness.
F. 24 port empty patch panels shall be Hubbell #HPJ24 or equal
   1. Panels shall have rear cable support bar for strain relief which shall clip to the rear of the patch panel or to the rear of the rack rail.
   2. Each 24-port patch panel shall be equipped with one (1) rear cable organizer. Organizer shall be Hubbell #HPRCMB or equal.
   3. Ports shall be marked 1-24 on top of the openings by factory.
   4. Label all Panels for the panel, communications room and rack with a large laser-printed label.

2.10 PASS THRU’S

A. Where no pass-thru is provided by others the contractor shall install conduit or UL listed wall pass thru's sized as required to route all cables through all walls.
B. Pass thru's shall be EMT conduit or another UL listed rated device.
C. Install thru all drywall, block, concrete walls and through any floors required to be penetrated
D. Conduit shall be supported mechanically from the wall or floor structure. After installation, the raceway shall be firestopped to meet the requirements of the wall or floor.
E. Install a sticker on the wall, next to the pass thru, listing the UL approved method that was used to firestop the pass thru or conduit.

2.11 PATCH CORDS
A. Contractor shall provide one patch cord for each data cable installed. Patch cords shall be at the communications room.
   1. Provide a patch cord for each CAT-6 or CAT-6A cable installed
B. Patch cords shall match the type of cables installed. Provide CAT-6 patches for CAT-6 cables. Provide CAT-6A patches for CAT-6A cables
C. Patch cords shall be 8" or 12" long and shall match the color of the cable/jack they are being plugged into.
   1. Provide Yellow Patch Cords for Wireless Access Points
   2. Provide Green Patch Cords for Security Cameras
   3. Provide Blue Patch Cords for all other data cable connections.
D. Patch cords shall be 28 AWG, small diameter cords
   1. CAT-6 cords shall be Panduit #UTP28SP8IN* where * is the color
   2. CAT-6A cords shall be Panduit #UTP28X8IN* where * is the color
E. Patch cords shall be 28 AWG, small diameter cords
   1. CAT-6 cords shall be Hubbell #HCL6xxyy where xx is the color and yy is the length. 01 length is 12"
   2. CAT-6A cords shall be Panduit # HCL6Axxyy where xx is the color and yy is the length. 01 length is 12"

PART 3 - EXECUTION

3.01 EXAMINATION
A. Examine all pathways prior to installation of all cables.
B. Identify locations of all user conduits and backboxes prior to cable installation.
   1. Walk the site during conduit installation and ensure that all boxes are installed where required for termination of all cables.
   2. If any missing locations are not noted during electrical raceway installation the contractor shall be required to fish the wall or install surface raceway to support the cable terminations
C. The Engineer or the Owner has the right to make adjustments to the location of any outlet to a new location within 7 wall-feet of the original location. If the change is made prior to final cable termination, and prior to any raceway being installed, then the changes shall be a no cost change to the contract.
D. Identify all locations where cable will route through furniture raceway or other nonstandard conduit or raceway installation. Make arrangements to install and terminate all cables in accordance with TIA/EIA 568 standards.

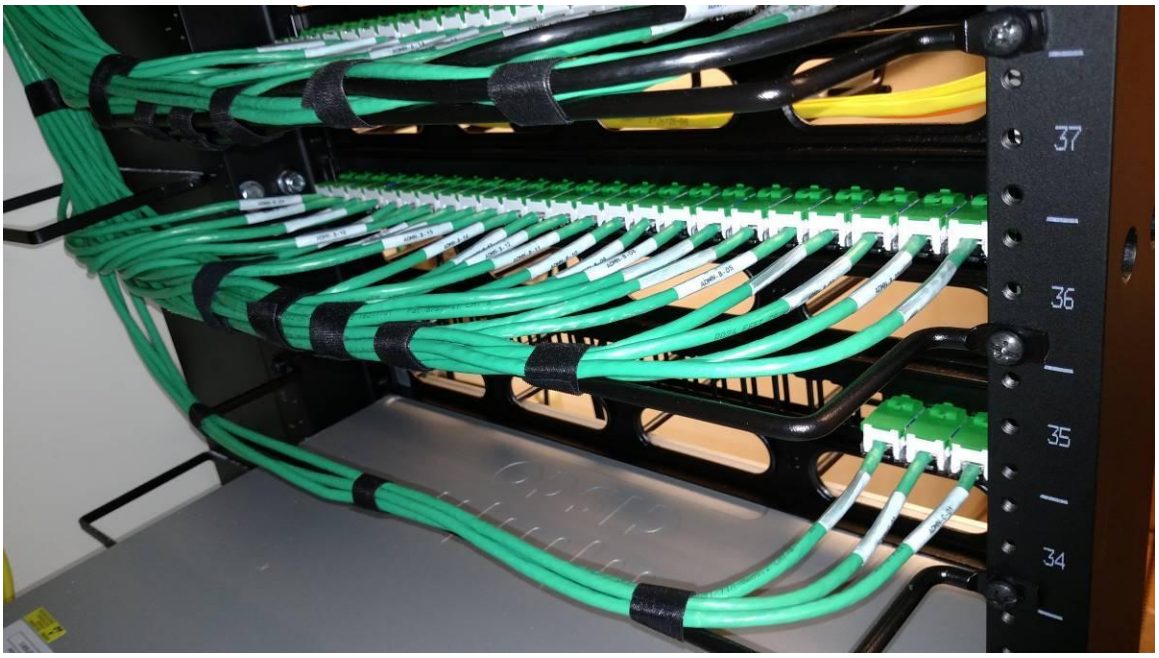
3.02 PREPARATION
A. Locate main path for all cables and install J-hooks where cable tray or raceway is not provided.
B. Coordinate with other trades to install a clear, straight path down major corridors for the routing of user cables back to the communications closet.
C. Plan installation of cables along cable ladder of rack system in communications room. All cable shall be neatly routed in groups of no more than 24 cables.

3.03 INSTALLATION

A. CAT-6 and/or CAT-6A cabling shall be installed according to TIA/EIA 568 standards, including all updates and addenda.

1. When installing CAT-X cables, care shall be taken to avoid crimping or bending the cable past the manufacturer's recommended bend radius.
2. During installation, the cables shall not be pulled across the ceiling tiles or the structure of the building. This may cause damage to the cable jacket.
3. Adhere to all pulling tensions and bend radii during installation. Excessive pulling or bending can cause the cable to fail tests after installation. Any cable that does not pass the certification tests after installation shall be fixed or replaced at the Contractor's expense.
4. All cables shall route neatly in the ceiling. Whether they route in cable tray or J-hooks, the cables shall be neat and orderly.
5. Cables shall not be laying on or against the building structure. Cables shall not be laying on or against electrical or HVAC pipes.
6. Cables shall not be installed between the building structure and corrugated steel of the roof deck.
7. There shall be no more than 24 cables in each J-hook. Provide additional J-hooks as required.
8. Support all cables at a minimum of every 5 feet.
9. Provide a short coil of extra cable where the cable enters the vertical conduit. The coil shall consist of no less than 1-1/2 feet.
10. Provide enough slack in the backbox to fully remove the faceplate and jack and allow work to be done on the cable.
11. When installing cables in the communications room, all cable shall route neatly through the cable tray and cable ladder.
12. When transitioning from the ceiling area to the cable ladder of the rack system, all cable shall route through conduits or be attached to vertical section of cable ladder. The Contractor shall provide the conduits shown and any additional conduits or cable ladder required to neatly transition cables from the ceiling to the rack.
13. Bundle cables in groups of no more than 24 cables as it routes along the cable ladder.
14. Cables shall route down each side of a rack for termination. Split each panel into 2 sides. The first 12 positions on a panel are on the left, and positions 13 through 24 are on the right. Route the cables for panel positions 1 through 12 down the left cable ladder and route the cables for positions 13 through 24 down the right cable ladder.
15. Each patch panel shall utilize a rear organizer for holding the cables as they route to the punchdown field.
16. Cables shall be bundled in groups of 4 as they route through the rear cable organizer.
17. When terminating cables, ensure that the smallest amount of jacket is removed from the final termination point of the cables.
18. Pair twists shall be maintained up to the IDC jack for all the cables.
19. Provide a service loop of the cables on the vertical cable ladder. The loop shall extend no less than 1 foot below the termination point on the patch panel. Route the cables 1 foot below the patch panel, and then back up to the panel. This will provide room for future moves and additions to the rack.
20. Each cable shall have a self adhesive, self laminating, laser printed label at each end. The label shall show the location identifier of that cable. Labels shall be installed no more than 4 inches from the termination point of the cable.

B. All work on the project shall meet all applicable state, federal, local and industry codes and be installed according to the requirements of he Authority Having Jurisdiction (AHJ).



Detail 01. Proper routing and support of cables on rear organizer. Where possible route 12 cables from right side and 12 cables from left side. This rack in picture did not have right side organizer.



Detail 02. Cable routing from above ceiling to cable ladder and to racks Route all cables neatly.

C. CAT-6 and CAT-6A data jacks shall be installed at the user end of each UTP cable installed in the system.
   1. Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination.

2. Jacks shall be installed per manufacturer's instructions and properly mounted in plates, frames, housings, or other appropriate mounting devices.
3. Jacks shall be installed such that cables terminated to the jacks maintain minimum bend radius of at least 4 times the cable diameter into the workstation outlet. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.
4. See drawings for the color requirements of all modular jacks.

D. Faceplates shall be mounted straight and level with the floor and walls of the building.
1. Jacks and/or connectors shall be terminated to the appropriate cable and inserted in the correct orientation into the faceplate prior to the mounting of the faceplate.
2. Jacks shall be inserted into the faceplate left to right, then top to bottom. 2 gang plates shall be labeled left to right, then top to bottom for each gang.
3. Cable slack shall be stored behind the faceplate in such a way that allows the minimum bend radius of the cables to be maintained as per the following:
4. Care shall be taken when mounting the faceplate to avoid crimping or kinking the cables.
5. Faceplates shall be securely mounted to a surface mounted housing, a recessed box, or box eliminator bracket.
6. Each faceplate shall be labeled with laser printed paper inserted behind the clear plastic label strips.
7. The label shall show the location identifier of the faceplate and the letter designation for each cable. The label shall be as large a font as possible and easily readable.
8. Each faceplate comes with a label strip at the top and the bottom.

E. Wall mount phone plates shall be mounted to a backbox or a drywall ring securely installed to the wall.
1. Terminate the cable to the 8-position jack on the wall mount faceplate.
2. Ensure that the faceplate is at the correct height for all ADA requirements.
3. Provide an adhesive label on the faceplate identifying the cable with its location identifier number.

F. When utilizing 106 style or GFI/Style-Line brackets, the Contractor shall provide self adhesive labels detailing which cable is at each position.
1. 106 plates and GFI plates will primarily be located in floorboxes or surface raceway.
2. The contractor shall coordinate the faceplates required with the actual floorboxes installed by the electrical contractor.
3. Provide the quantity of GFI and 106 style plates required.

G. Surface Mount boxes
1. Modular Jacks and/or connectors shall be terminated to the appropriate cable and inserted in the correct orientation into the surface mount box.
2. When the surface mount jack is mounted above the ceiling the cable shall be coiled and the cable and surface mount box shall be kept off of the ceiling grid
3. Attach the coil to the building structure with a plenum rated tie-wrap.
4. Label each surface mount box for the cable number. Also, install a wrap-around label on each cable.
5. When attaching a surface mount box to a piece of furniture or to a power pole the contractor shall drill a hole in the furniture/pole that is larger than the hole on the back of the surface box.
6. Screw the surface box to the furniture or to the pole. Adhesive only solutions are not adequate.

H. Proper support of cables is of paramount importance when installing a cable infrastructure. All cables not in conduit or cable tray shall be supported via J-hooks a minimum of every 5 feet.
1. Routes of cables shall be parallel or perpendicular to the walls of the building.
2. Install the J-hooks to minimize changes in the level of the cables as they route through the J-hooks.

3. Do not install more than 50 cables in any 1 J-hook. Provide additional hooks where more than 50 cables route along a main route.
4. All communications shall route as high in the ceiling as possible while still being accessible and staying away from other utilities.
5. When installing the cable through the J-hooks, they shall all have relatively the same droop between hooks. All cables shall be installed neatly and squarely.
6. Secure the J-hooks to the building structure with beam clamps and threaded rod as required to support the cables.
7. J-hooks shall never be attached to drop ceiling support wires. Cables shall never be supported by drop ceiling wires.

I. CAT-6 patch panels shall be installed in the racks.
1. Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the modular jack at the patch panel shall be no greater than a 1/2 inch (13 mm).
2. Panels shall be installed per manufacturer's instructions and properly mounted to a rack, cabinet, bracket, or other appropriate mounting device.
3. Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts.
4. Each patch panel shall have a rear cable organizer for routing cable from the vertical cable ladder to the patch panel. 1 organizer for each row of 24 cables.
5. The label for each outlet on the panel shall be the same as the wraparound label on each end of the cable.
6. Each label shall line up directly below or above the outlet on the panel. Misaligned labels will not be permitted.

J. Patch Cords
1. Provide patch cords into the communications room where they are to be installed
2. Mark the box with the date they are placed in the room and quantity of each type of patch cable.
3. Send picture of the box to the designer and owner

END OF SECTION 28 1600

SECTION 28 1705 – CLOCK SYSTEM -IP-Poe

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section provides a project overview and general project and Contractor requirements for the Internet Protocol (IP) Power over Ethernet (PoE) clock system

1.02 DESCRIPTION OF PROJECT

A. The building shall receive an entirely controlled master clock system and associated IP clocks. CAT-6 cables shall be used from the clock to the comm room for connectivity. See drawing and specs for contractor that is to install the cables
   1. The system shall consist of, but not be limited to clocks and antenna systems that transmit the time to the clocks.

1.03 CONTRACTOR

A. The Contractor shall accept complete responsibility for the installation, certification, and support of the system. Contractor must show proof that they have the certifying manufacturer's support on all of these issues.

B. All work shall be performed and supervised by technicians and project managers who are qualified to install the clock system and to perform related tests as required by the manufacturer in accordance with the manufacturer's methods.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The manufacturer of the wireless master clock system shall have been designing, manufacturing, and installing systems for a period of no less than 3 years.

B. Approved manufacturers for the paging bell system are:
   1. Sapling
   2. Others as equal.

2.02 MATERIALS

A. Master Clock System:
   1. The Contractor shall provide a fully functional, IP based controlled master clock system.
   2. The clock system shall consist of all software and electronics required to provide accurate time at each clock. This shall include, but not be limited to, software, configuration, wiring, and all clocks located throughout the building.
   3. All clocks shall be connected to the Ethernet network and controlled through a network attached NTP server.

B. Digital IP Clocks:
   1. All clocks shall be digital clocks with green digits. Red Digits are not allowed
   2. Clocks shall have integral receivers that attach to the Ethernet network and derive power from the PoE on the Ethernet cable.
   3. Provide custom backbox for flush mounting in new walls.
      a. Provide backbox to electrical contractor or cabling contractor who is installing raceway.
   4. Provide custom backbox for surface mounting in existing walls. Provide raceway to accessible ceiling from the backbox.
   5. Clocks shall be self-correcting at a minimum of each hour.
   6. Clocks shall have the following specifications or better:
      a. Power over Ethernet (802.3af protocol)
      b. Power and synchronize clocks through one Ethernet cable using RJ45 connector

c. Control all of your settings like Daylight Saving Time and countdown functions through an easy-to use web interface
d. Scheduled dimming schedules for digital clocks
e. Edit a specific clock's settings or apply settings to the entire clock system through one location
f. Available in different sizes
A) 2.5" (6.35 cm) display
B) 4" (10.16 cm) display
C) 4-digit display
D) 6-digit display
g. Automatic bi-annual Daylight Savings Time
h. Alternating time/date in both U.S and International formats
i. 12 or 24-hour display
j. Four levels of adjustable brightness

7. Digital PoE, IP clocks shall be Sapling SBP-3100 series, includes surface mount housing:
a. Sapling Digital, IP, 3100 Model, 2.5", 4 Digits, PoE, Green Display, Surface Mount #SBP-31S-254-0G
b. Sapling Digital, IP, 3100 Model, 4.0", 6 Digits, PoE, Green Display, Surface Mount #SBP-31S-406-0G

C. PoE Ethernet switch
1. Contractor shall provide the Ethernet switch in each comm room to connect all clocks that are installed.
2. Ethernet switches shall provide power to drive each clock
3. Provide switch to connect to the owners Ethernet network.

PART 3 - EXECUTION

3.01 GENERAL
A. Contractor shall be familiar with the location(s) where the work will be done. No additional compensation will be made for items the Contractor claims he was not aware of during bidding.
B. Work Area:
1. All work areas shall be cleaned at the end of each day. All debris shall be cleaned and removed from the site and disposed of in the approved container for the site.
2. All equipment shall be moved out of common areas and stored in the Contractor's lay down area, or in other approved storage locations on site.
3. Any work that is low hanging, or may otherwise impede the general use of the space, and cannot be removed shall be flagged and cordoned off by the Contractor.
C. All equipment and parts shall be installed in a neat and workman like manner. Good installation principles shall be used throughout the project.

3.02 INSTALLATION
A. Clock Configuration.
1. Configure each clock to point to the same NTP servers.
2. Configure for each clock.
a. Configure each clock with an IP address
b. Name all clocks in the system
c. Configure dimming schedules of each clock.
3. All clocks shall be set to exactly the same time. The Contractor shall verify the correctness of the clocks.
4. The clock system shall run for a minimum of 2 weeks prior to being turned over to the Owner. During that time, the Contractor shall keep a daily log of the time and ensure that the system is keeping the correct time each day. Any variations from the accepted standard time shall be noted and shall be corrected by the Contractor. The system

shall not be turned over to the Owner until 2 straight weeks have passed during which the system has been shown to keep the correct time.

B. Clock Connectivity
   1. Confirm with the cabling contractor (if cables are being installed by another contractor) how the cables shall be installed and terminated.
   2. Provide with all patch cables required at each end. At clock and at comm room
   3. Plug in each clock and confirm power and network connectivity
C. Surface Mount Clocks
   1. Identify location of backboxes with electrician prior to installation.
   2. Install surface mount boxes to the backboxes in the wall.
   3. Connect network cables
D. Clocks mounted in the Gymnasium shall be protected by polycarbonate covering.
E. All clocks shall be installed straight and level.

END OF SECTION 28 1705

SECTION 28 3100 - FIRE ALARM

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PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements.”

1.02 SUMMARY

A. This Section includes design and installation of a new fire alarm system.

B. Related Sections include the following:

1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.03 **DEFINITIONS**

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.04 **SYSTEM DESCRIPTION**

A. Noncoded, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.

B. Fire alarm system shall consist of the following:

1. All new fire alarm control panel, devices, and wiring.
2. System smoke detection above all control panels and notification appliance power supply panels.
3. System smoke detection as required at air handling units, smoke rated transfer openings, and smoke damper locations.
4. System smoke detection in areas identified on plans.
5. System carbon monoxide detection in areas identified on plans.
6. All flow and tamper switches to monitor fire sprinkler and standpipe systems and report appropriate alarm and supervisory signals.
7. Manual fire alarm boxes at each building exit (prior to entering exit stairwells at each floor).
8. Audible and visual notification appliances in all public and common areas of the building.
9. Elevator Recall

1.05 **PERFORMANCE REQUIREMENTS**

A. Comply with NFPA 72.

B. Comply with NFPA 70.

C. Comply with NFPA 720.

D. A complete functional system meeting the requirements of this specification, including alarm initiating devices and notification appliances at locations and ratings to meet the requirements of the Authorities Having Jurisdiction and all applicable codes shall be provided.

E. Coordinate and avoid conflicts with casework, markerboards, feature walls, and other areas where fire alarm devices would interfere with furnishings, finishes, etc.

F. Fire alarm system vendor shall provide sound pressure level calculations demonstrating compliance with NFPA 72 and establish quantities and tap settings of audible devices.

G. No additional charges for work or equipment required for a code compliant system approved by the Authority Having Jurisdiction will be allowed.

H. Obtain and refer to mechanical drawings for smoke damper locations, smoke rated transfer openings, and air handling equipment CFM’s. Provide smoke detection as required by applicable codes.

I. Coordinate with fire protection contractor and approved shop drawings for all control and monitoring requirements of the fire protection system.

J. Premises protection includes Education Type building use group.

1. Refer to drawings for complete code analysis including construction type, use groups, special occupancy types, rated walls, smoke barriers and partitions, etc.

K. System functional performance shall be as indicated on the fire alarm matrix on the drawings.

1.06 **ACTION SUBMITTALS**

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: For each type of product indicated.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.

2. Include rated capacities, operating characteristics, and electrical characteristics.

C. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.

2. Include plans, elevations, sections, and details, including details of attachments to other Work.

3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.

4. Annunciator panel details as required by authorities having jurisdiction.

5. Detail assembly and support requirements.

6. Include voltage drop calculations for notification-appliance circuits.

7. Include battery-size calculations.

8. Include input/output matrix.

9. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.

10. Include performance parameters and installation details for each detector.

11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

12. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.

13. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.

a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.

b. Show field wiring and equipment required for HVAC unit shutdown on alarm.

c. Locate detectors in accordance with manufacturer's written instructions.

d. Show air-sampling detector pipe routing.

14. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.07 **INFORMATIONAL SUBMITTALS**

A. Qualification Statements: For Installer.

B. Field quality-control test reports.

C. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.08 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
    a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
    b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
    c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
    d. Riser diagram.
    e. Device addresses.
    f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
    g. Record copy of site-specific software.
    h. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
        1) Equipment tested.
        2) Frequency of testing of installed components.
        3) Frequency of inspection of installed components.
        4) Requirements and recommendations related to results of maintenance.
        5) Manufacturer's user training manuals.
    i. Manufacturer's required maintenance related to system warranty requirements.
    j. Abbreviated operating instructions for mounting at FACU and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media and approved online or cloud solution.
3. Device address list.

4. Printout of software application and graphic screens.

1.09 **MAINTENANCE MATERIAL SUBMITTALS**

A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Smoke Detectors and Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
2. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
3. Keys and Tools: One extra set for access to locked or tamper-proofed components.
4. Audible and Visual Notification Appliances: One of each type installed.
5. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.
6. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.

1.10 **QUALITY ASSURANCE**

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Work of this Section be performed by a UL-listed company.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 PRODUCTS

2.01 **MANUFACTURERS**

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

1. FACP and Equipment:
   a. National Time & Signal.

2.02 **FACP**

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864, 9th edition, listed.
2. Addressable initiation devices that communicate device identity and status.
   a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
   b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
3. Addressable control circuits for operation of mechanical equipment.
4. Mounting: Flush.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Signaling Line Circuits between control panels: NFPA 72, Class A, Style 7
2. Signaling Line Circuits from control panel to devices: NFPA 72, Class B, Style 4.
   a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.
3. Notification-Appliance Circuits: NFPA 72, Class B, Style Y.
4. Actuation of alarm notification appliances, emergency voice communications, annunciation, smoke control, elevator recall, and actuation of suppression systems shall occur within 10 seconds after the activation of an initiating device.
5. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel FACP indication and system reset if the alarm is not verified.

E. Elevator Controls: Heat detector operation shuts down elevator power by operating a shunt trip in a circuit breaker feeding the elevator.

1. A field-mounted relay actuated by the fire detector or the FACP closes the shunt trip circuit and operates building notification appliances and annunciator.

F. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

G. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

H. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and

sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through cellular communicator in accordance with NFPA 72 requirements.

1. Communications path cellular

a. UL-listed cellular communicator shall serve as the secondary path.

b. The communicator shall automatically transmit alarm, supervisory, and trouble signals.

c. Cellular transmission shall meet or exceed the performance and supervision requirements of NFPA 72 for dual-path systems.

d. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

K. Voice/Alarm Signaling Service: A central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of the FACP.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones, or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall be UL 1711 listed.

a. Allow the application of and evacuation signal to indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.

b. Programmable tone and message sequence selection.

c. Standard digitally recorded messages for "Evacuation" and "All Clear."

d. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACP.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones.

3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

L. Service Modem: The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and cellular communicator shall be powered by the 24-V dc source.

1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."

N. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.

1. Battery and Charger Capacity: Comply with NFPA 72.

O. Surge Protection:

1. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

P. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.03 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
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.

2.04 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
    a. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

C. Beam-Type Smoke Detector:

1. Xtralsis Open-Area Smoke Imaging Detection (OSID).
2. UL 268 listed, operating at 24-V dc, nominal.
3. Smoke Detector: Dual wavelength particle detection with optical imaging.
4. Transmitters and Receivers: Each detector shall consist of the maximum number of transmitters per receiver, as specified by the manufacturer conditions.
5. Adjustable Sensitivity: At least three sensitivity levels, settable at the receiver, measured as percent of obscuration.

6. Misalignment Angle: Minimum tolerance of 1°.
7. Two selectable alarm delay settings, allowing each to be associated with a corresponding sensitivity.
8. Trouble signal delay, fixed at 20 seconds.
9. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status with remote indicator panels.

D. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:
   a. Sensor: LED or infrared light source with matching silicon-cell receiver.
   b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
   a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where required.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay Fan Shutdown: Provide two (2) sets of contacts rated to interrupt fan motor-control circuit.

2.05 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate-of-rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.

1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.06 SYSTEM CARBON MONOXIDE DETECTORS

A. General Description:

1. UL 2075 listed, operating at 24-V dc, nominal.
2. Provide means for addressable connection to fire-alarm system.

3. Detector must communicate detector status (normal, alarm, or trouble) to the FACP.
4. Detector must send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Detector must provide alarm contacts and trouble contacts.
6. Mounting: Adapter plate for outlet box mounting.
7. Testable by introducing test carbon monoxide into sensing cell.
8. Locate, mount, and wire in accordance with manufacturer's written instructions.
9. Test button simulates alarm condition.

2.07 NOTIFICATION APPLIANCES

A. Description: 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.
2. Finishes:
a. Wall mounted appliances: Provide red finish with white lettering.
b. Ceiling Mounted Appliances: Provide white finish.

B. Voice/Tone Speakers:
1. UL 1480 listed.
2. High-Range Units: Rated 2 to 15 W.
3. Low-Range Units: Rated 1 to 2 W.
4. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
1. Rated Light Output: 15, 30, 60, 75, 110, 135, 185 candela as required to meet NFPA 72 requirements.
2. Strobe Leads: Factory connected to screw terminals.

2.08 REMOTE STATUS AND ALARM INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.09 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.
1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 24-V ac or dc.

B. Material and Finish: Match door hardware.

2.10 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Class 1.

B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.11 ADDRESSABLE MONITORING MODULE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

2.12 ADDRESSABLE CONTROL MODULE

A. Provide for integration of auxiliary control functions into the analog signaling circuit. Intelligent analog signaling circuit control module shall have the following capabilities:

1. Communication interaction with the analog signaling circuit having the capability of initiating a control function to an auxiliary device based on a specified event.

2. Provide NO/NC contact pairs rated at 2 amps 120 VAC or 24 VDC.

2.13 GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of the device.

2. Finish: Paint of color to match the protected device.

2.14 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Fire alarm wire and cable shall be as specified by the system manufacturer including conductor gage, conductor quantity, conductor twists and shielding required to meet NFPA class and style performance specified.

C. Signaling Line Circuits and other power limited fire alarm circuits (PLFA):

1. PLFA circuits installed in conduit or raceway: U.L. Listed type FPL

2. PLFA circuit cable installed exposed in accessible ceiling spaces, risers and elsewhere: U.L. Listed type FPLP.

3. PLFA circuits installed where 2 hr rating is required to meet the survivability requirements of NFPA 72: Circuit integrity cable, NFPA 70 Article 760, Classification CI, UL listed as Type FPL, FPLR or FPLP as required, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

D. Non-Power-Limited Fire Alarm Circuits (NPLFA):

1. NPLFA circuits installed in conduit: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

a. Low-Voltage Circuits: No. 16 AWG, minimum.

b. Line-Voltage Circuits: No. 12 AWG, minimum.

2. NPLFA circuit cable installed exposed in ceiling spaces, risers and elsewhere: Multi-conductor cable, U.L Listed type NPLFP.

3. NPLFA circuits installed where 2 hr rating is required to meet the survivability requirements of NFPA 72: Multi-conductor cable, U.L Listed type NPLFP-CI

PART 3 EXECUTION

3.01 **EQUIPMENT INSTALLATION**

A. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet, or the listed spacing of the detectors, whichever is less.

2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.

3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct.

D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

E. Remote Status and Alarm Indicators: Install near each smoke detector, each duct detector and each sprinkler water-flow switch and valve-tamper switch that is above 10’-0” aff, concealed, or otherwise not readily visible from normal viewing position. Coordinate exact locations with local fire department and submit to architect for approval.

F. Audible Alarm Notification Appliances: Install wall mounted appliances not less than 6 inches below the ceiling.

G. Visible Alarm Notification Appliances: Install wall mounted appliances at 96” AFF or 6 inches below the ceiling, whichever is less.

H. Coordinate ceiling mounted appliances with reflected ceiling plans. Do not install visual appliances where pendant mounted or suspended lighting fixtures will obstruct intended viewing angles.

I. Install wall mounted and ceiling mounted notification appliances flush on recessed j-box or back box for all new work and on existing gyp-board partition walls.

J. Install notification appliances on existing CMU walls on surface back-boxes matching the dimensions and finish of the notification appliance.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

L. FACP: Surface mounted with tops of cabinets not more than 72 inches above the finished floor.

1. Install smoke detector above panel. Install on ceiling for ceilings under 10 ft. For ceilings above 10’, wall mount a smoke detector listed for releasing service 10’ AFF or 1’ below finished ceiling (whichever is lower).

M. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

N. Provide all 120V branch circuits for all control panels, sub panels, and ancillary equipment required for the system.

3.02 **WIRING INSTALLATION**

A. Install wiring according to the following:

1. NECA 1.

2. TIA/EIA 568-A.

B. Wiring Method:

1. Fire alarm circuits shall consist of multi-conductor cables installed in accessible ceiling spaces.
2. Where ceilings consist of exposed construction, fire alarm multi-conductor cable shall be installed on top of joists, beams etc. and shall be concealed from view. Where the structural elements do not allow for the cable to be installed in a concealed fashion, then install the cable in conduit.
3. Install fire alarm cable in conduit in mechanical rooms, loading docks and similar service spaces.
4. Drops to surface mounted devices shall be installed in conduit or surface raceway. No exposed cable shall be visible below the ceiling. Where the ceiling is exposed, route the conduit or raceway up to the structural member that will conceal the cable.
5. Drops to devices recessed in partition walls shall be installed in conduit.
6. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
7. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits, if the system manufacturer permits it.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.03 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section “Electrical Identification."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.04 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.

2. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.

3. Testing: Follow procedure and record results complying with requirements in NFPA 72.

a. Detectors that are outside their marked sensitivity range shall be replaced.

4. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.06 PROGRAMMING

A. Coordinate final address descriptions for alarm, supervisory and trouble indication that appear on FACP and Annunciator displays with the Owners representative. This shall include all room names, room numbers, building areas for fire protection zones, exit door descriptions and similar items. This coordination shall take place and be implemented in the programming prior to Demonstration and Owner Training.

3.07 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

C. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.08 WARRANTY

A. All newly installed equipment shall be warranted by the contractor for a period of one year following acceptance. The warranty shall include parts, labor, prompt field service, pickup and delivery.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures/Demonstration and Training."

END OF SECTION

SECTION 28 3500 – PHYSICAL ACCESS CONTROL SYSTEM (PACS)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes parts and equipment required for installation and termination of a building-wide Physical Access Control System (PACS). This system shall be referred to as the “security system”, “system” or PACS throughout these specifications.

1.02 SYSTEM DESCRIPTION

A. The security system shall be supplied and installed by a Contractor able to show examples of similar projects and installations within the last 3 years.

B. The security system shall serve the building but shall be able to be expanded to serve additional buildings in the future.

C. The Security System shall provide a solution for access control and alarm monitoring. This shall be through a central server with PC attached workstations for monitoring and control. Shall include:

1. Access Control
2. Alarm Monitoring
3. Badging and user database/Photo imaging
4. Video and Audio intercoms

D. Contractor shall provide all software required for connection of the security system to the in-house data network and associated control PC’s.

E. The security system client-server architecture shall communicate with native TCP/IP over an existing Ethernet TCP/IP enterprise network.

1.03 COORDINATION

A. All cables shall be coordinated with the door hardware and security devices being installed as part of this project.

B. PACS cable shall be a unique color from the Telecommunications cable, fire alarm cable and lighting control cable. Coordinate this with the Electrical Contractor prior to ordering the equipment and installation of the cables.

1.04 PROJECT PLAN

A. Prior to ordering equipment and installation, the contractor shall provide a project plan to the owner and contractor that describes the system and its capabilities and the possible configurations.

B. Provide a project approach which describes the installation and implementation plan and schedule and all sequencing.

C. Meet with the owner numerous times to determine how the system should work and how it should be monitored.

1. Configure the system prior to installation to meet these requirements. Demonstrate the system use to the owner prior to installation and obtain approval to move forward with the installation.

D. Generate a testing plan and have that plan approved by the owner and engineer prior to installing the system.

E. The system shall be installed and tested prior to cutting over any doors to the system. Provide and install temporary card readers, door contacts etc to the system for testing. Demonstrate that this works prior to cutover.

F. Conduct all testing of the system

G. Conduct user training on the system

H. Provide as-built documentation of the installed system

1.05 RELATED STANDARDS

A. The security system shall conform to the following international and national standards:

1. FCC Rules and Regulations

2. UL 294 Access Control Systems
3. UL 1076 Line Supervision
4. 21 CFR part 11
5. Part 15, Radio Frequency Devices
6. National Electrical Manufacturers Association (NEMA.)
7. Applicable Federal, State and Local laws, regulations, codes
8. National Electrical Code (NEC)
9. NFPA 80 National Fire Protection Agency - Fire Doors & Windows (edition is jurisdiction dependent).
10. NFPA 101 National Fire Protection Agency - Life Safety Code (edition is jurisdiction dependent).
11. NFPA 105 National Fire Protection Agency - Smoke Control Door Assembly (edition is jurisdiction dependent)
12. ANSI 117.1 1992 Edition Providing Accessibility and Usability for Physically handicapped People.
13. A.D.A.A.G Americans with Disabilities Act Accessibility Guidelines.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved vendors for security cables are:
   1. General Cable.
   2. Belden.
   3. West Penn Wire and Cable.
   4. Equivalent manufacturers.

B. Approved manufacturer for panels and power supplies are:
   1. Altronix
   2. Life Safety

C. Approved vendor for Physical Access Control System (PACS) equipment is:
   1. Lenel S2 OnGuard
   2. The owner has an S2 system existing. Expand this to the new spaces or renovated spaces to support new door and access control systems.
   3. Expansion of the system shall utilize Mercury boards for all new panels.

D. As part of the bid the contractor shall explicitly detail the software package that is provided and shall provide a document showing all software available from the manufacturer.
   1. The document shall explicitly state which software is provided as part of the bid and shall detail other software available but not provided as part of the bid.
   2. We require this to be able to determine the level of software available and will allow us to fully review the system as a whole.

2.02 DESCRIPTION OF PROJECT

A. The owner has an existing Lenel S2 OnGuard system in place
B. Expand this system to support new end point devices.
C. Fully integrate the new panels and end point devices to the system.
D. See drawings for end points and devices to be connected.
E. The access control system shall be an all-encompassing system that is large enough to serve numerous employees and be extended to numerous buildings. The system shall, collect data and monitor doors and entrances at:
   1. No less than 10 Buildings
   2. Support no fewer than 2000 users
F. The original installation will be for the building(s) noted on the drawings. The system installed shall not preclude the extension of the system to other buildings.
G. The system shall include all equipment, software, cabling, data collection points, card readers and hardware to monitor and control the specified devices and provide reports to a security station as required by the owner.

H. If an Intrusion Detection system is specified, then the access control and intrusion detection system shall act as one system. They shall be integrated such that the presentation of a known access card will shunt all intrusion alarms for the door where the card was presented.
I. The system shall keep records of all access control card presentations.
J. The system shall connect to and interoperate with all the door hardware that which is existing and being added as part of this project.
K. The system shall be able to be connected to other buildings via the existing data network. Specify how the system will connect to other buildings as part of your bid response.
L. The Owner shall be able to change and monitor all settings for intrusion and access to all the buildings through the control PC.

2.03 MATERIALS

A. All security and control cables shall be plenum rated.
   1. Contractor shall provide all appropriate cable from the door security hardware to the security system. All cabling shall be plenum rated.
   2. Some locations require outdoor rated cabling. The contractor shall provide the cabling to match the required area.
   3. There will be requirements for many different types of cabling and the contractor shall provide for each.
   4. Provide a coil of cable at each location for moves and maintenance.
B. The system shall be fully configurable and compartmentalized so that any user can be assigned and they will only see the status of doors at one building.
   1. Based on a user's login, the system shall be configurable to restrict persons from seeing or controlling doors and lock schedules at building that they do not have permission to see or control.

2.04 SECURITY SYSTEM SERVER

A. Management Server:
   1. Server/Appliance for Lenel S2 OnGuard is existing
   2. Configure new devices and new users on the system.
   3. Contractor shall connect the Server to the Ethernet in the building.
   4. Provide all equipment required to mount the Server in the cabinet/rack
   5. Server shall connect to the Access Control Module via the Ethernet network

2.05 ACCESS CONTROL SYSTEM SOFTWARE

A. Software shall be Lenel S2 OnGuard
B. Provide, install and configure

2.06 SECURITY ENCLOSURE

A. Shall be provided to hold power supplies, controllers, access control panels, card reader panels, input/output cards (now to be referred to as security panels) and any other components required for a complete access control system.
B. Security enclosures are the physical boxes and cabinets that support the intelligent controllers, I/O boards, power supplies and power distribution equipment.
C. Security panels hall be wall mounted and large enough to hold power equipment and access control system controllers and cards.
D. Security panel shall be:
   1. UL: Listed: UL 294 approved
   2. Enclosure shall accommodate power supply and sub-assemblies such as controllers and security cards to be provided as part of the project.
   3. Primary power input shall be 115VAC
   4. Physical
      a. Size enclosure as required to hold power supplies and security panels. Provide multiple enclosures where required.
      b. Made of 16 AWG sheet metal

c. Shall have conduit knockouts or custom cut holes for access to the panels for cabling.
d. Be equipped with an internal cam lock
e. Be equipped with a tamper switch that shall be wired to the I/O for software alarm when the panel is opened.
f. Shall have space for batteries to support the access control system.

5. Equip with a backplate that shall support direct mounting of the security panels and power devices
6. Equip with magnetic cable supports that attach to the backplate to support cables.

E. Security Enclosure shall be Altronix Trove series or equal.

2.07 PLYWOOD TO BE MOUNTED BEHIND ALL SECURITY PANELS.

A. Plywood shall be American Plywood Association (APA), Grade A-C at minimum. Meaning that the “A” side is smooth and paintable, neat repairs are permissible. “C” side allows knotholes to 1 inch and limited splits are permitted. “A” side is used for mounting; “C” side is installed towards the wall.
B. Plywood shall be 3/4-inch-thick and shall come in 4 foot x 8 foot sheets with a quantity of sheets installed as per the detailed drawings.
C. All plywood used for wallfields shall be fire-retardant plywood and shall be stamped as such.
1. Shall have a Flame-spread rating of 25 or less,
D. Each piece of plywood with one coat of white paint. Paint all edges.
1. Do not paint over one of the Fireproof stamps on the plywood. Leave this so that the owner can identify that the plywood installed is fire-retardant.

2.08 POWER SUPPLIES AND POWER DISTRIBUTION

A. Power supplies and power equipment shall be provided that support the entire access control system, security panels/controllers, door locks and all other field equipment of the access control system.
B. All power supplies shall be connected to 120VAC power with a hardwired connection. Install cable and connect to power.
1. Provide and install conduit, wiring and connections required for 120-volt power connectivity.
C. Power supply shall be mounted to the enclosure. Shall include:
1. Shall provide power to the panels in the enclosure and field devices.
2. Shall include multiple 12 or 24 volt outputs. Shall be settable on the panel
3. Input voltage of 120VAC with a fuse
4. Classified as a Power-Limited stand-alone power supply with stand-by battery and suitable to power sensors and electro-mechanical devices (e.g. electric door strikes), as defined in the National Electrical Code/NFPA70/NFPA72
5. Shall be sized for outputs of 1 thru 16 unique outputs.
6. Battery connection for charging on-board batteries.
7. Fire alarm disconnect
a. Shall support Normally Open or Normally Closed trigger
b. Shall be set to latching or non-latching
8. LED indicators for:
a. AC input
b. DC output
c. Battery discharged or no battery
9. Over Voltage protection
10. Short Circuit protection
11. Power supply shall be Altronix #eFlow series or equal.
a. Provide actual part that provides for all power and control of the system as required to meet the manufacturers requirements and these specifications.
12. Equip with an Ethernet Module for panel control and monitoring:

a. Shall support remote supervision, control and monitoring over an Ethernet connection.
b. Connect to the owner's network and setup monitoring.
c. Altronix #Linq2 or equal

D. Access Power Controllers
1. The Power Controller shall have the following characteristics:
a. Powered by 12 VDC or 24 VDC from the power supply/charger board or via 8-Pin connector to stack with Voltage Regulator for dual voltage (12VDC & 24VDC) outputs from a single 24VDC input, up to 6 Amps
b. Spade lug connectors to facilitate the transfer or sharing of 12VDC and/or 24VDC power between Access Power Controllers or Power Distribution Modules
c. 8 trigger inputs to correspond with similarly numbered triggered controlled outputs, with each trigger input being in one of the following forms:
1) Normally open (NO) contact
2) Open collector
d. 8 independently trigger-controlled outputs with the following output options:
1) Fail-Safe filtered and electronically regulated power outputs
2) Fail-Secure filtered and electronically regulated power outputs
3) Form "C" relay outputs, rated 5 amps @ 28 VDC/VAC.
4) For each triggered output, LED indication of an active output.
5) Bi-colored LEDs for visual verification of voltage (12VDC or 24VDC) per output
6) An unswitched auxiliary power output, rated at 2.5 amps (fused) or 2 amps (PTC), used in lieu of a trigger-controlled output.
7) Fuse protected
e. FACP (Fire Alarm Control Panel) interface
1) input options from the FACP:
A) polarity reversal
B) Normally Open - Non-Latching or Latching with reset
C) Normally Closed - Non-Latching or Latching with reset
2) Ability for the FACP to trigger any of the trigger-controlled outputs
3) Trigger indications:
A) LED indicator on the module
B) Form "C" output relay contact rated 1 amp @ 24 VDC
f. Current protection
1) access control module: 10 amp fuse
2) individual outputs: 2.5-amp Class 2 rated PTC device
2. Access power controller shall be Altronix #ACMS8 or equal.

E. Power Distribution board with voltage regulator.
1. The Power Distribution Module shall be a UL Listed Sub-Assembly board level product comprised of fused protected outputs to furnish 12 VDC, 24 VDC or 24 VAC power to surveillance, security, access control systems and components, and other security-related equipment.
2. Power distribution module shall include:
a. The Power Distribution Module shall employ a single distribution board.
b. The Power Distribution Module shall output 5VDC to 24VDC up to 10A each or 16VAC to 28VAC up to 14A each.
c. Fused protected outputs.
d. Individual voltage LEDs indicate 12VDC (Green) or 24VDC (Red and Green)
3. Modules shall provide for:
a. Dual Power Supply Inputs.
b. Outputs shall be switch selectable as to route power via Input 1 or Input 2.

c. Shall be stacked with a voltage regulator and connected via eight (8) pin connector.
d. Individual voltage LEDs indicate 12VDC (Green) or 24VDC (Red and Green).
e. Eight (8) individually fused device protected outputs.

4. Power distribution board shall be Altronix #PDS8 or equal
   a. Equip with a voltage regulator Altronix #VR6 or equal.

F. Battery Backup
1. The enclosure shall have battery backup UPS circuit with built-in battery charger that shall provide automatic battery backup UPS power in event of AC line failure.
2. Each controller enclosure panel shall have a battery for power failure. Battery shall be fully enclosed in a metal cabinet.
3. The battery shall provide for full UPS operation for a minimum of 30 minutes
4. Batteries shall not be mounted in the enclosure where they would cover a control or door panel in the enclosure.
5. Provide larger enclosure or secondary enclosure for batteries.
6. Where a battery only enclosure is provided, label this enclosure with a label that says “ACCESS CONTROL PANEL BATTERIES”

2.09 ACCESS CONTROL MODULE/CONTROLLER

A. The Contractor shall provide intelligent controller modules / cards for the security system that utilize a true distributed processing technology with local processing at each controller.
1. Shall provide for an open architecture.

B. One module per communications room or immediate adjacent enclosures shall provide for communications with the server/software via on-board 10BaseT/100BaseTX Ethernet port and support TLS encryption as a minimum security implementation.

C. In the event system communications is lost or the server/cloud fails, all networked intelligent controller, (controllers or security panels or modules, terms will be used interchangeably) shall provide complete control, operation, and supervision of all monitoring and control points based on the latest database information.

D. The controller shall provide centralized biometric template management and support a wide range of reader technologies, including OSDP, Wiegand, magnetic stripe and biometric.
1. Control module shall support, as a minimum the following open standards:
   a. PSIA Area Control,
   b. SNMPv3/v2c,
   c. OSDP and OSDP SC.
2. The controller shall utilize a cryptographic module, like OpenSSL FIPS Object Module RE, that is validated to FIPS 140-2 thus providing a certified implementation of Transport Layer Security.
3. Security on the controller shall include:
   a. Host/Controller connection protected by TLS 1.2/1.1 or AES-256/128
   b. Controller/IO Expansion connection protected by AES
   c. Generate and load custom peer certificates for TLS
   d. Port based network access control using 802.1X
   e. Crypto memory chip
   f. FIPS 140-2 user of OpenSSL
   g. HTTPS protection for installer web pages
   h. Secure cookies
   i. SNMPv3/v2c
   j. DIP switch toggle sets 5-minute time to disable webpage access
   k. Disable default login credentials
   l. Authorized IP address filtering
   m. IP Client Proxy
   n. Bulk erase controller and periphery devices during replacement
   o. Strong password enforcement

4. Door Control on controller shall support:
5. One or two-reader ports: Clock and Data, Wiegand, or RS-485
    a. Eight programmable inputs, four relays, diagnostic LEDs
6. Access Control shall support:
    a. 240,000 Cardholder capacity
    b. 50,000 Transaction buffers
    c. If/Then Macro capability
    d. Adjustable cardholder capacity
    e. Supports up to 520 inputs and 516 outputs
7. Card Formats supported shall include:
    a. 16 card formats per active reader, 8 per offline reader
    b. Entire card number reported on invalid read
    c. 19-digit (64-bit) User ID and 15-digit PIN numbers maximum
    d. PIV, CAC, TWIC card compatible
    e. 255 Access Levels per card holder
    f. Activation/Deactivation Date or Date & Times
8. Card Reader Functions shall include:
    a. Multiple card format support by reader
    b. Paired reader support
    c. Alternate reader support
    d. Elevator support
    e. Turnstile support
    f. Biometric device support
    g. Open Supervised Device Protocol (OSDP) and OSDP SC compliant
    h. Occupancy count
    i. Support of multi-occupancy rules
    j. Anti-pass back support
    k. Area-based, reader-based, or time based
    l. Nested area, hard, soft, or timed forgiveness
    m. Supports host-based approval rules
    n. Keypad support with programmable user commands, card input
    o. Shunt relay support
    p. Strike follower relay support
    q. Threat level and Operating Modes
    r. Host controlled OSDP reader passthrough
    s. Elevator floor override

E. The controller shall be configured to avoid system failure. In the event of a server or system failure, transactions are to be stored at the controller until the server and connection is back online. Once it is online then the information shall be downloaded to the server.
    1. The controller shall be utilized as the “brains” of the security and access system. All door contacts, card readers, request to exit contacts, assisted openers, door controllers, electric latch devices, electric strikes and other devices shall connect to the controller.
        a. Controllers shall be microprocessor-based, multi-tasking, multi-user, and use real-time, digital control processors.
        b. Each control panel shall consist of modular hardware including power supply, CPU board, and various input/output modules.
        c. Memory at the controller shall be large enough to store 10,000 card holder information points.
        d. Controllers shall be able to be updated via remote connectivity or direct connectivity. Updates shall be for new firmware or software updates.
    2. Controller shall be fully configurable by the Owner via a Microsoft Windows type interface through the operator workstation or through offsite connectivity through the IP network.

3. Controllers shall mount in enclosure on the wall where noted on the drawings.
4. Provide the quantity of controllers required for all electronic door locks, card readers and all other devices noted on the drawings and specifications.
    a. Each controller shall have onboard LED's for self-diagnosis.
5. Each controller shall support IP communications. Additional communications shall be via RS-232 and or RS-485.
6. Shall include a real-time on-board clock synchronized with Server.
7. Where the door hardware installer provides a door interface or door controller card that works with the electric latch/strike and request to exit button, the communications contractor shall provide the correct interface to read data and send data to the door controller.
8. The link to other systems shall take place at the controller as well as through the I/O boards so that in the event of failure or an alarm. the rest of the system shall continue to function correctly.
9. The maximum time for door opening from the proper presentation of a card shall be less than one second.
10. ADA assisted Openers
    a. Controller shall interface with ADA openers and ADA door buttons.
    b. At some doors, there are assisted openers. At these doors, the controller shall completely work with the opener. Include equipment, cabling, connections and programming to allow the doors to function as per below:
        1) When approaching from the exterior and doors are locked:
            A) Present a card and then door shall be unlocked. Push the auto opener and the door shall open.
        2) When approaching from the exterior and doors are unlocked:
            A) Push the auto opener button and the door opens.
        3) When approaching from the interior and doors are locked:
            A) Push the auto opener button and the door shall unlock and open.
        4) When approaching from the interior and doors are unlocked:
            A) Push the button and the door opens.
11. Controller shall connect to the fire alarm system. In an alarm condition, the controller shall unlock doors as required to allow people to enter and exit the building. The Contractor shall provide all cabling, software and hardware required to interface with the fire alarm system as well as the video security system.
12. Controller with Ethernet connectivity shall be Mercury LP Series or equal
13. Controller with RS-485 connectivity shall be Mercury MR Series or equal

F. I/O Cards/Modules shall be installed in the enclosures and attached to the controller to allow input and output to the field devices throughout the building(s).
1. Provide additional modules or boards to support all control, access and security points shown on the drawings and described in the specifications.
    a. I/O boards shall pop in and pop out. Replacing a board for a certain point shall not require shutting the entire controller down.
2. Modules shall be installed to connect to the field devices, including but not limited to:
    a. Door contacts,
    b. Request to exit devices,
    c. Push buttons/Panic buttons
    d. Toggle Switches
    e. Assisted door opener devices and door opener buttons
    f. Motion sensors.
    g. Strobe lights
    h. Embarrassment alarms / exit alarms
    i. Lockdown buttons with Lockdown Status Light
    j. Other field devices noted
    k. All other security devices required and shown on the drawings.

3. Modules shall translate information from the field devices to the controller and thus the server for records and access control.
4. I/O Card shall be provided that serve access control devices such as door contacts and garage contacts. These cards shall provide alarms when the contact is “open”. The time before alarm shall be fully configurable by the owner.
5. Output types shall be digital/analog for control of doors. In addition to the door output, the control module shall contain auxiliary outputs for ON/OFF control of other devices.
6. Shall provide inputs and outputs to monitor and control non-reader-based system points, such as door contacts, motion sensors, gate actuators, ADA Buttons and ADA openers etc.

2.10 CREDENTIALS

A. ID Cards/Keyring Fobs:
   1. All Credentials for users are existing.

2.11 DOOR LOCKING DEVICES

A. Latch Retraction device: “LR” on drawings
   1. The door hardware installer will install a Latch Retraction device as shown on the drawings.
   2. Provide and install a power supply in the communications room to power the LR device. Review the door hardware and match the power supply to the Latching Retraction devices. Provide quantity as required to power all LR devices
   3. The security contractor shall wire from the LR device to a power supply in the communications room and then to the controller panel in the communications room.
   4. Provide cards in the controller panel and equipment to allow the security system to interface with the LR.
   5. The LR shall be able to be held open based upon a time schedule put forth in the security system. It shall also be able to be retracted upon presentation of a valid card or fob to the card reader.
   6. See door hardware specifications for transfer hinge and wiring harness provision plans.
      a. If wiring harness is provided as part of door hardware:
         1) Wire from door harness, through raceway and back to the power supply in the comm room. Wire to security panel for control of the door.
         2) Provide custom wiring and connectors to connect to the wiring harness
      b. If no wiring harness is provided as part of the door hardware.
         1) Wire from the LR, through the hinge and back to the Power Supply in the comm room. Wire to security panel for control of the door.
      c. Provide manufacturers recommended cabling type and wire gauge.

B. Electric Strike. “ES” on drawings
   1. The door hardware contractor shall install the Electric Strikes.
   2. The contractor shall wire from the ES to the security panel. Provide cabling to control the ES and power the ES.
   3. Provide power supply in the comm room to power the ES.

2.12 READER DEVICES

A. Card Readers: “CR” on drawings
   1. Refer to the drawings for locations where card readers “CR” are required.
   2. Card readers shall be combo readers that read standard 125 khz readers for standard prox and 13.56 MHz “smart” cards and 2.4Ghz (Bluetooth) compatibility.
   3. Card readers shall be completely compatible with the security/access system.
   4. Card readers shall be mountable in a single gang box or in the frame of a door. Refer to drawings for locations.
   5. Readers shall be sealed to allow outdoor installation.
   6. Power requirements for the card shall be between 12 volts DC.

7. Reader must be capable of providing a read range up to 2” for proximity/Smart cards without modification.
8. Mobile credential range shall be 3”. In Tap mode. Tap mode is a setting on the card reader.
9. Reader shall operate in a temperature range of minus -31°F to 150°F.
10. Reader shall be designed for both surface mounting and mounting on a single-gang electrical box.
11. Reader shall have a tri-color light emitting diode (LED. and audible tone for noting of accepted read or rejected card read.
12. Reader shall flash the LED green momentarily and emit a short beep to indicate that a card was read.
13. Shall communicate via Wiegand and or OSDB (Secure RS-485)
14. Card readers on single-gang boxes shall be HID Signo #40NKS—00-000000 or equal.
15. Card readers on the frame of a door shall be HID Signo #20NKS—00-000000 or equal.
16. Keypad Reader.”KR: on drawings
    a. Card readers with numeric keypad, on a single-gang backbox shall be HID Signo #40KNKS-00-000000 or equal
    b. Card readers with numeric keypad, on mullion shall be HID Signo #20KNKS-00-000000 or equal

2.13 DEVICES AT THE DOOR

A. Door Contacts; “DC” on drawings. Single Pole, Double Throw, Form C
1. Contractor shall install magnetic door contacts in the top of each door required to be monitored. See drawings for door contact “DC” locations.
2. Install industry standard magnetic door contacts into the top of the door and the matching contact into the header of the door.
3. Contacts shall be compatible with the security/access system and intrusion detection system. Each contact point shall be defined in the software and shall be given an alphanumeric designation.
4. Contacts shall connect back to the controller **and** intrusion detections system.
    a. Connect cable to the PACS System as an input.
5. In locations where there are double doors, two contacts shall be installed and the connections shall be made so that the opening of each door is detected.
6. When the contact is installed in the recessed part of a metal doorframe, an appropriate, solidly attached metal support shall be used. The tolerance “gap” shall be adjusted to the frame and the door.
7. Wire door contacts back directly to an I/O card in the controller panel. DC’s shall not be wired through Request to Exit devices.
8. Door contacts shall be 1” diameter.
9. Door Contacts shall be George Risk Industries, GRI #194-12 or equal



10.

B. Garage Contacts “GC on drawings, Single-pole, Double-throw
1. Garage contacts shall be used for roll up garage doors.

2. Install the contact on the wall or on a custom bracket along the side of the door. They are not to be mounted on the floor.
3. Create a custom bracket to mount the contact.
4. Mount other magnet on the door. Create a custom mount if required.
5. Contacts shall connect back to the controller **and** intrusion detections system.
   a. Connect cable to the PACS System as an input.
6. Garage Contact shall be Honeywell #958-2 or equal.



7.

C. Motion request to Exit Connections: “MX” on drawings
1. On doors marked with a “MX” the Contractor shall install and connect a motion based request to exit switch that is mounted above the door.
2. Refer to the doors on the drawings with “MX.”
3. Contractor shall connect all “MX” doors to the security/access system to shunt the alarm when a person engages the MX switch at the door. This shall allow persons to leave the building without triggering the alarm even when the doors are locked and armed.
4. Contractor shall provide all cabling and programming required for all request to exit connections. These cables shall be directly back to the controller panel and shall not be tied directly to door contacts
5. Each “MX” shall include a configurable sensor pattern and shall have a LED indicator light.
6. MX shall be Honeywell #IS310 or equal.



7.

D. Hard-wired Request to Exit devices “RX” on drawings
1. These devices are located in the latch retraction devices or electric lock devices.
2. These devices are provided and installed by the door hardware contractor.
3. Security contractor shall wire from the RX to the I/O panel in the network controller.

E. Embarrassment Alarm Bell/Buzzer: “EA” on drawings.
1. The communications contractor shall install an alar/bell where noted on the drawings.
2. The alarm bell shall provide a noise when an action occurs and is triggered from the access control system
3. When the system is armed and a door contact is opened the alarm / bell shall sound, alerting the person who opened the door that the system is in an alarm mode.
4. This shall be set for a timed duration of no more than 30 seconds. Configure the system to support this duration.
   a. Shall be set at 85 dB

b. Shall work with power between 6VCD and 28VDC

5. Shall be on a single-gang, stainless-steel faceplate.
6. Alarm shall be Alarm Controls #TS-41 or equal
7. 

2.14 AUTO OPERATOR DOOR INTERFACES

A. Assisted Opener “AO” on drawings
   1. The contractor shall wire to the assisted door openers where shown on the drawings.
   2. The wiring shall allow integration of the working of the door locks, card readers and the push to open buttons.
   3. The work shall include wiring and integration at the doors and at the controller panel to allow the Assisted Openers to work as required by the owner. See specs and drawings for additional information.
   4. Connect cabling to the security panel and the assisted opener and assisted opener buttons to complete system connectivity and configuration.

B. Assisted Opener Buttons. “AB” on drawings
   1. Assisted opener button is provided by others.
   2. Wire from the “AB” devices inside the vestibule and inside the building to unlock the door and then trigger the door to open when exiting the building.
   3. Provide all cabling to connect the AB devices to the access control system.
   4. Configure the security system to unlock doors as people exit the building and push the opener buttons to exit.

2.15 FIELD DEVICES

A. Security Contacts/Contact Closures: “CC” or “SC”
   1. Contractor shall provide an interface in the controller for connections to dry contact closures of other systems.
   2. Dry contact shall cause an alarm on open or closed state depending on Owner required configuration of the controller.
   3. Contractor shall provide all cabling and configuration required interfacing the security/access system with all security contacts.
   4. Contacts shall be provided as per the drawings and shall interface with the other systems as shown.

2.16 DEVICES AT THE OPERATOR DESK

A. Pushbutton Release: “PB” on drawings
   1. The drawings show a “PB” where required. This shall function to facilitate the immediate or direct deactivation of an electro-magnetic lock or electric latch or electric strike or other programmed series of events when depressed.
   2. The push button shall allow the temporary deactivation of the supervisory systems of a controlled door to permit access without generating an alarm (authorized access.
   3. Push buttons shall be below the desk or as noted by the owner.
   4. Wire back to the IO panel in the networked controller
   5. PB shall be Alarm Controls #TS-18 or Schlage 660 series or equal.

6. 

or 

2.17 INTERCOM –IP BASED

A. Intercom (Audio/Video) at doors; “IC“ on drawings

1. At locations shown on the drawings, the Contractor shall install audio/video (IC) Intercom devices to allow visitors to contact the office to announce themselves and to gain entry into the building.
   a. Connectivity of the components shall be via manufacturer CAT-6 cables to the data network. This shall be from the exterior interfaces, throughout the system and to the Ethernet network inside the building.
   b. Shall connect to standard SIP devices for audio and video connectivity.
   c. Shall interface with standard video security software to allow recording of camera on each intercom.
   d. Power and data shall be via the Ethernet network and CAT-6 cabling.
2. Audio/video intercoms “IC” at the door shall have the following characteristics:
   a. Device shall have a single, 1-touch, push-button for calling into the interior base station. This shall open a 2-way communications path between devices.
   b. Shall have a color camera inside the intercom that is viewable at the interior base station.
   c. Include the backbox for custom mounting. Provide weather proof equipment outdoors.
3. Outdoor intercom, Surface mounted audio/video intercom, IP based,
   a. Surface mounted Stainless Steel intercom shall be Aiphone #IX-DVF or equal.
      1) Equip with Surface box, Aiphone #SBX-IDVF
   b. Door Frame mounted intercom to fit on the door frame shall be Aiphone #IX-DVM or equal.

B. Base Station (BS) There shall be an audio/video intercom station at the noted offices.

1. The audio/video intercom shall be connected to the IP network and logically attached to all intercoms at the doors.
2. The audio portion of the station shall have a volume control.
3. The video portion of the station shall control camera view.
4. There shall be a door release button that interfaces with the access control system and unlocks the door that is calling.
5. Shall include:
   a. SIP 2.0 Compliant allowing integration with Cisco Unified Call Manager®.
   b. ONVIF® Profile S Compliant
   c. 802.3af PoE, Class 0
   d. 7″ TFT LCD touchscreen
   e. Hands-free or push-to-talk communication
   f. 8 customizable speed dial buttons
   g. 2 contact outputs, 4 trigger inputs
   h. 8Ω 1/2 watt speaker output provides better coverage for announcements

i. 600Ω audio input.

6. The interior audio/video intercom shall be Aiphone #IX-MV7-HW-JP or equal

C. IP Adapter for control of doors
1. Provide an adapter in the comm room near the access control panel to interface between the intercom system and the intercom
2. Provide a 4 contact inputs and 10 relay outputs. Provide quantity required for control of all doors equipped with an intercom (IC)
3. Relay adapter shall be Aiphone #IXW-MAA Programmable Relay Adaptor:
a. This shall contain no less than 4 Contact Closure Inputs and 10 Contact closure outputs.

D. Cabling for the audio/video interfaces at the doors and other components shall be plenum rated.
1. Provide the type and quantity of cables required for connectivity. Review manufacturer's requirements and provide adequate cabling.
2. Install a wrap-around cable at each termination point of the interconnection cables. The label shall detail which device the cable connects to.
3. Install cabling to allow the office device to release the lock on the door where the exterior intercom is located.
4. Install cabling and configure the system to support integration between the intercom and the push button that is installed at ADA height.

E. Pass Thru's
1. Where no pass-thru is provided by others the contractor shall install conduit or UL listed wall pass thru's sized as required to route all cables through all walls.
2. Pass thru's shall be EMT conduit or another UL listed rated device.
3. Install thru all drywall, block, concrete walls and through any floors required to be penetrated
4. Conduit shall be supported mechanically from the wall or floor structure. After installation, the raceway shall be firestopped to meet the requirements of the wall or floor.

2.18 WIRES AND CABLES

A. The contractor shall be responsible for supplying and installing all cabling to make the system operational.
1. Size conductors as required to transmit all power and signal to all devices.
2. All cabling shall be Plenum rated
3. All cabling shall be installed in raceways and in accessible ceiling spaces through cable supports.
4. Provide manufacturer specified cabling based on use and length of signal transmission from panel to device.
5. Generate drawings showing the cables required and get those reviewed by the designer prior to installation.
6. All cabling shall be labeled at each end with laser printed wrap-around labels

B. Plenum type, multi-conductor "Banana-Peel" type cabling shall be used where a Card Reader and door contact and electronic lock are utilized on one door or close two-door group.
1. Overall cable shall contain numerous other sub-cables within. Those shall minimally include:

Element Description	Element	Number of Element	Size	Stranding	Material
Card Reader	Pair(s)	3	18 AWG	7x26	BC - Bare Copper
Door Contact	Conductor(s)	2	18 AWG	7x26	BC - Bare Copper
REX/Spare	Conductor(s)	4	18 AWG	7x26	BC - Bare Copper
Lock Power	Conductor(s)	4	16 AWG	19x29	BC - Bare Copper

2. Inner Jacket

Element Description	Color
Card Reader	Orange
Door Contact	White
REX/Spare	Blue
Lock Power	Gray

3. All jackets and portions of the cable shall be Plenum Rated.
4. Cable shall be Belden #638AFS or equal

C. Install individual cables where required or where individual devices are to be installed. Identify cable type required by the device and provide and install the appropriate cable.
1. Install Plenum rated cable in all plenum rated areas.
2. Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
   a. NFPA 70, Type CMP.
   b. Flame Resistance: NFPA 262 Flame Test.
3. Plenum Rated, PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
4. Plenum-Type, RS-485 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and fluorinated-ethylene-propylene jacket.
   a. NFPA 70, Type CMP.
   b. Flame Resistance: NFPA 262 Flame Test.
5. Multi-conductor, Readers and Wiegand Keypads Cables: No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.
   a. NFPA 70, Type CMG.
   b. Flame Resistance: UL 1581 Vertical Tray.
   c. For TIA/EIA-RS-232 applications.
6. Paired Readers and Wiegand Keypads Cables: Paired, 3 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
   a. NFPA 70, Type CM.
   b. Flame Resistance: UL 1581 Vertical Tray.
7. Paired Readers and Wiegand Keypads Cable: Paired, 3 pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation,

individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
a. NFPA 70, Type CM.
b. Flame Resistance: UL 1581 Vertical Tray.

8. Plenum-Type, Paired, Readers and Wiegand Keypads Cable: Paired, 3 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum foil-polypropylene tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
a. NFPA 70, Type CMP.
b. Flame Resistance: NFPA 262 Flame Test.
9. Plenum-Type, Multiconductor, Readers and Keypads Cable: 6 conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
a. NFPA 70, Type CMP.
b. Flame Resistance: NFPA 262 Flame Test.
10. Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
a. NFPA 70, Type CMG.
b. Flame Resistance: UL 1581 Vertical Tray.
11. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
a. NFPA 70, Type CMP.
b. Flame Resistance: NFPA 262 Flame Test.
12. Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
a. NFPA 70, Type CMG.
b. Flame Resistance: UL 1581 Vertical Tray.
13. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
a. NFPA 70, Type CMP.
b. Flame Resistance: NFPA 262 Flame Test.
14. Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, overall aluminum foil-polyester tape shield with No. 22 AWG, stranded (7x30) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
a. NFPA 70, Type CMR.
b. Flame Resistance: UL 1666 Riser Flame Test.
15. Plenum-Type, Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, aluminum foil-polyester tape shield (foil side out), with No. 22 AWG drain wire, 100 percent shield coverage, and plastic jacket.
a. NFPA 70, Type CMP.
b. Flame Resistance: NFPA 262 Flame Test.
16. Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (7x26) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
a. NFPA 70, Type CMG.
17. Plenum-Type, Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, fluorinated-ethylene-propylene insulation, unshielded, and plastic jacket.
a. NFPA 70, Type CMP.

b. Flame Resistance: NFPA 262 Flame Test.

18. Elevator Travel Cable: Steel center core, with shielded, twisted pairs, No. 20 AWG conductor size.
    a. Steel Center Core Support: Preformed, flexible, low-torsion, zinc-coated, steel wire rope; insulated with 60 deg C flame-resistant PVC and covered with a nylon or cotton braid.
    Shielded Pairs: Insulated copper conductors; color-coded, insulated with 60 deg C flame-resistant PVC; each pair shielded with bare copper braid for 85 percent coverage.
        1) Jute Filler: Electrical grade, dry.
        2) Binder: Helically wound synthetic fiber.
        3) Braid: Rayon or cotton braid applied with 95 percent coverage.
        4) Jacket: 60 deg C PVC specifically compounded for flexibility and abrasion resistance. UL VW-1 and CSA FT1 flame rated.

PART 3 - EXECUTION

3.01 EXAMINATION

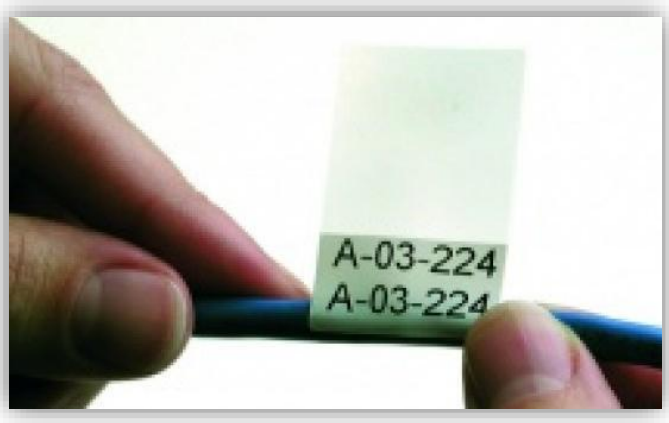
A. Examine all pathways prior to installation of all cables and raceways.

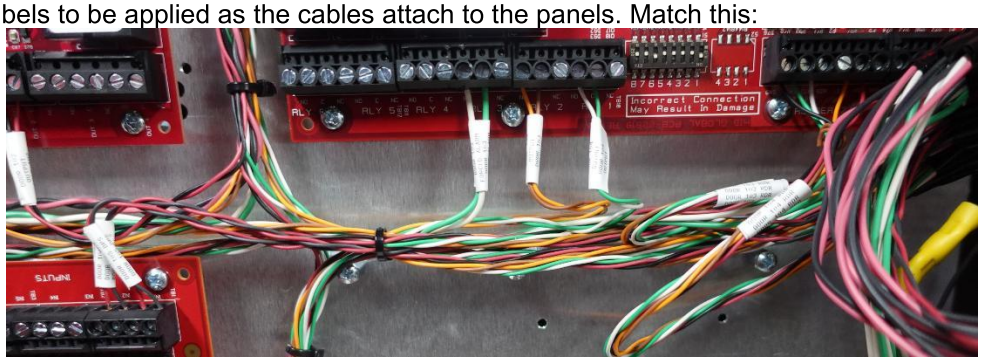
3.02 PREPARATION

A. Locate main path for all cables and install J-hooks where cable tray is not provided.
B. Coordinate with other trades to install a clear, straight path down major corridors for the routing of security/access cables back to the communications closet.
C. Plan installation of cables along wallfield in communications room. Provide finger-duct and D-rings for support of cables. See drawings

3.03 INSTALLATION-GENERAL

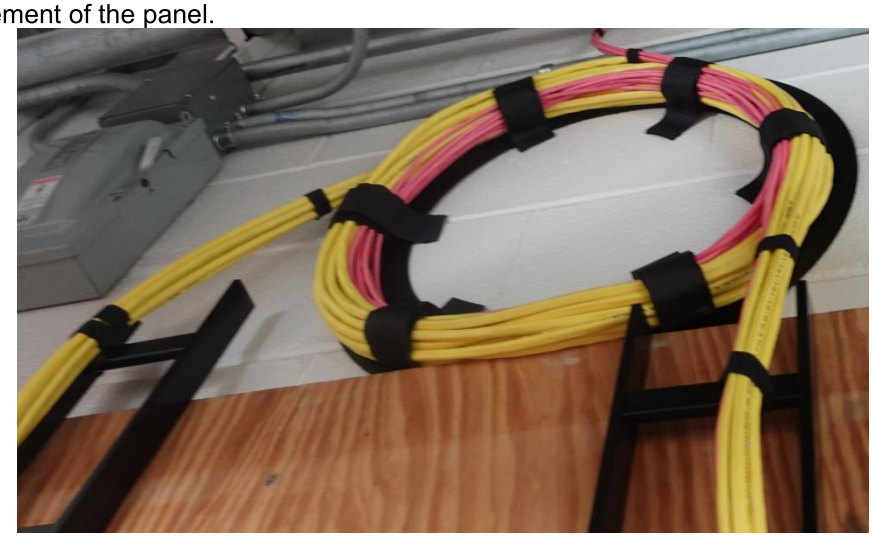
A. Security/access cable shall be installed per industry standards.
    1. Install all cabling required for complete system connectivity. Cabling shall be plenum rated.
    2. Care shall be taken to avoid crimping or bending the cable past the manufacturer’s recommended bend radius.
    3. During installation, the cables shall not be pulled across the ceiling tiles or the structure of the building. This may cause damage to the cable jacket.
    4. Adhere to all pulling tensions and bend radii during installation.
    5. All cables shall route neatly in the ceiling. Whether they route in cable tray or J-hooks, the cables shall be neat and orderly.
    6. Support cables at a minimum of every 5 feet.
    7. When routing security/access cables parallel to electrical conduits and lighting ballasts, the cable shall maintain a clearance of at least 12 inches. When running perpendicular to electrical conduits and lighting ballasts the cable shall maintain 6 inches of clearance.
    8. Provide a short coil of extra cable where the cable enters the vertical conduit. The coil shall consist of no less than 1-1/2 feet.
    9. When installing cables in the communications room, all cable shall route neatly through the cable tray and cable ladder.
    10. Provide a service loop of the cables on the wallfield.
    11. Each cable shall have a self adhesive, self laminating, laser printed label at each end. The label shall show the location identifier of that cable. Labels shall be installed no more than 4 inches from the termination point of the cable.



12.
13. Door labels on exterior of panel. Match this.
    a. 
14. See labels to be applied as the cables attach to the panels. Match this:
    a. 

B. Firestopping is required at all riser conduits, and all pass thru's.
   1. Each cable tray penetration of a wall shall be firestopped after cable installation. Use pillow type firestop to allow additional cables to be installed in the future.
   2. Where riser conduits pass through floors, the area between the concrete and the conduit shall be firestopped. This shall be completed with a putty or liquid firestop product. Fill in the space with mineral wool, and then install the firestop on top. All firestop shall be of sufficient thickness to secure the rating required by code.
   3. After final cable installation, install a putty firestop around all cables where they enter and exit conduit pass thru's and conduit risers.
   4. Firestop as per AHJ requirements.

C. Cabling at the Panel.

1. Contractor shall coil all spare cable from the door devices outside the security panel and shall neatly coil the cable on the wall. Provide 5’ minimum in the coil for future movement of the panel.
   a. 
2. Cables shall route into the panels through a grommeted hole that is sized for the cables entering.
3. All cables shall be installed in a neat and workmanlike manner.
4. Cables shall be terminated and shall allow for removal of a card without un-terminating the cables.
5. All cables shall be neatly distributed to the card in the panel.
6. All labels shall be visible inside the panel near the termination point. Label cables equidistant from their termination point.
   a. Typical routing and cable organization in an access control panel.
   b. Route all cables along a central path.
   c. Label the cables as they entre the panel for the door to which they connect.
   d. Support cables along the backplate
   e. Label all interconnection cables with wrap-around labels that detail what they connect to.
7. Typical Trove Style panel

a. 

D. Proper support of cables is of paramount importance when installing a cable infrastructure. All cables not in conduit or cable tray shall be supported via J-hooks a minimum of every 5 feet.
   1. Routes of cables shall be parallel or perpendicular to the walls of the building.
   2. Install the J-hooks to minimize changes in the level of the cables as they route through the J-hooks.
   3. All communications shall route as high in the ceiling as possible while still being accessible and staying away from other utilities.
   4. When installing the cable through the J-hooks, they shall all have relatively the same droop between hooks. All cables shall be installed neatly and squarely.
   5. Secure the J-hooks to the building structure with beam clamps and threaded rod as required to support the cables.
   6. J-hooks shall never be attached to drop ceiling support wires. Cables shall never be supported by drop ceiling wires.

3.04 CONTROL PANEL INSTALLATION

A. Enclosure and power
   1. Contractor shall mount the enclosure on top of ¾” fireproof plywood.
   2. Mount enclosure in the location noted. Coordinate other equipment and wallfield systems.
   3. Locate the 120 volt power outlet and install enclosure in relation to power
   4. Size the enclosure to support all PACS devices noted on the drawings and in the specifications.
   5. Provide magnetic cable support devices in the panel to route cables inside the panel to the controllers and power devices
   6. Power.

a. Install cabling and raceway to connect the power supply in the enclosure to the 120 volt power outlet.
b. Shall be hard-wired power. Plug-in power is not allowed
c. Provide an electrician for connection of the power supplies if required by AHJ.

7. Battery backup
   a. Provide and connect the batteries to the power supply for the enclosure
   b. Test the battery supports the panel by removing 120 volt power after the system is fully up and operational.
8. Network connectivity
   a. Provide and install CAT-6 cable from the enclosure for the power supply to the communications rack. Connect to the Ethernet switch
9. Other Controllers and I/O Board connectivity.
   a. Provide and install cabling to connect the Ethernet controller to the other controllers and I/O boards via RS-485.
   b. Do not install RS-485 between communications rooms. Each comm room shall have an Ethernet attached Controller.

B. Controller:
1. Controller(s). shall be mounted in the enclosure as shown on the drawings.
2. Controller shall be sized for all security, access, control, and monitoring points existing on the drawings and shall be expandable.
3. Controller shall be able to be linked to additional controllers in other communications rooms/buildings via the Ethernet network.
4. Each port in the controller that is connected to a security point shall be labeled inside the controller box.
5. Label the outside of the panel with the door numbers and list of devices that are connected in that panel. Shall be laser printed adhesive labels.
6. Label the inside of the panel door with the layout of the panel and which controllers attach to which devices. Include door numbers on the diagram.
7. Depending on the type of panel the contractor shall provide cable routing hardware and equipment to neatly install cabling.
   a. Route cable to allow easy change and replacement of the individual control cards in the panel.
   b. Cabling shall be neatly bundled. See example below of adequate cabling being routed into a panel.
8. Network connectivity
   a. Provide and install CAT-6 cable from the controller to the communications rack. Connect to the Ethernet switch
   b. Connect on the Ethernet to the Switch.

C. Plywood behind panels.
1. Install all panels onto plywood in each comm room.
2. Paint plywood with prior to installation on the wall.
3. Plywood shall be installed from 12 inches AFF to 7 feet above the floor or as noted on the drawings.
4. Mount plywood to the wall with screws attached to studs in the wall. Contractor is responsible for securely mounting the plywood to the wall.
5. Grade “A” side of the plywood shall be used for mounting all communications components.
6. If the plywood will cover an electrical receptacle, the Contractor shall cut the plywood to allow access to the receptacle.

3.05 SERVER AND SOFTWARE INSTALLATION

A. Management Server:
1. Server/appliance is existing for the existing Lenel S2 On Guard system

2. Contractor shall provide and install software and licensing required to add devices and panels to the existing system.

B. Control Software:
1. Contractor shall provide all software required for a fully functional security/access system.
2. Software shall be installed and fully configured by the Contractor.
3. Contractor shall schedule meetings with the Owner prior to installation to determine the working of the security/access system.
4. Configuration of the security software shall include but not be limited to the following:
a. Number each door and any input and outputs associated with that door and associate it with a standard door name for easy review.
b. Meet with the owner to determine how they will use the system. Take information from them that will allow all custom settings of the software system. This shall include but not be limited to:
1) User groups based on building and administrative group
2) Access levels based on groups and times.
3) Door Groups for access and locking and unlocking schedules.
4) Building locking and unlocking schedules for each building
5) Administrative levels and super administrators
6) Building arming and disarming schedules of door contacts
7) Alarm level setting for different doors based on time of day and day of week.
8) Lockdown and Normal locking schedules. Configure the system to lock all doors upon going into lockdown mode through the button or through the software system.
9) Snow-Day override schedule that shall change when doors unlock and lock and which users or user groups are allowed to access the building during a snow day. Snow day shall revert back to regular scheduling afer 11 PM that day.
10) Setup all user logins to allow specific viewing of portions of the system based on login ID.
A) Detail in the setup that persons rights in working in the system.
c. Lockdowns and Secure
1) Create different locking schedules and processes for Lockdowns and Secure situations.
2) Work with the owner to determine what doors are locked or unlocked in a lockdown or secure situation.
3) Make all settings and groups required for each situation.
d. Set all alarm levels and outgoing outcalls for SMS and email alerts.
1) Add users and all those that are to be notified on a building basis.
2) Set levels for all door contacts such that the owner is notified of a door open when the system is armed but is not alerted during the day unless they ask for this type of configuration.
e. Generate customized maps for each building.
1) Create maps from the owner that have multiple levels such as entire building and then subdivided into different areas.
2) The maps shall show icons for each door. The icons shall be green or red based on open or closed door.
3) Setup all icons to allow the owner to click on a door and then have direct access to lock or unlock or pulse the lock on a door.

3.06 CREDENTIALS
A. All Physical Credentials and users are existing in the system
1. Associate new door devices with the owners existing groups of people

2. Configure specific new door devices with individuals as directed by the owner.
3. Work with the owner to apply system privileges and door access to each individual user.

3.07 DOOR LOCKING CONNECTIVITY

A. Electric Strike “ES” on drawings
   1. The note devices shall be installed by the door hardware contractor.
   2. Power supplies shall be located in the comm room. Provide and install power supplies. Connect power supplies to the controller panel.
   3. Install all cables required to be connected this device to the security system
   4. Review door hardware specifications to determine if a wiring harness is being provided by the door hardware supplier.
      a. Install cables from the controller panel and power supply in the comm room to the wiring harness. Connect to harness
      b. For EL devices, install harness from door hardware EL to the hinge, through the hinge and to the connection point for cables from the controller.
      c. For ES devices, install cabling from security panel to the Electric strike in the latch side of the frame.
      d. Wire from device, through frame and back to controller/power supply in the comm room.

B. Latch Retraction device. “LR” on drawings
   1. The Latch Retraction devices shall be provided by the door hardware supplier.
   2. Power supplies shall be located in the comm room. Provide and install power supplies. Connect power supplies to the controller panel.
   3. Install all cables required to be connect this power supply to the security system and to the actual Latch Retraction lock at the door.
   4. Review door hardware specifications to determine if a wiring harness is being provide by the door hardware supplier.
      a. Install cables from the controller panel and power supply to the wiring harness. Connect to harness
      b. Install harness from door hardware LR to the hinge, through the hinge and to the connection point above the door.
      c. Wire from connection point above door to the power supply and then to the security panel.
      d. If no harness is provided, then wire from LR device, thru the hinge, to the power supply controller and finally to the security panel.

3.08 READER INSTALLATION

A. Card Readers “CR” on drawings
   1. Card readers shall be installed at locations shown on the drawings.
   2. Review site and drawings and coordinate the wall mounted readers and frame mounted readers. Order the correct reader for each location.
      a. Conduct a site visit prior to ordering card readers.
      b. If the wrong reader is ordered then the contractor shall provide the correct reader.
   3. Coordinate installation of all card readers with the doors and walls.
   4. Where the reader is mounted on the door, coordinate the installation with the installation of the door to allow all cable for security/access.
   5. Locate all card readers at ADA compliant heights and locations.
   6. Wire and configure the card readers so that when the lock is engaged the light on the reader is red and when the door is unlocked the light is green.
   7. Garage Doors and Pedestals: At the garage doors and at pedestals the card readers shall be installed with a box that has a cover for the top of the card reader.

3.09 DEVICES AT THE DOOR

A. Door Contacts “DC” and Garage contacts “GC”:
   1. Install contacts where shown on the drawings. For mandoor contacts, install them at the top of the door.
   2. Work with door provider and installer on timing of door contact installation.
   3. Install raceways to allow installation of the door contacts if no raceway is provided inside the wall.
   4. Drill into the door frame and door to allow installation of the door contact and the associated cable. No cable shall be visible after installation.
   5. Where door frames are filled, they shall be drilled out to allow installation of the door contact. Surface mount contacts are not allowed unless specifically noted on the drawings.
   6. Wire back to the PACS panel and connect as an input.

B. Motion Request to Exit devices: “MX” on drawings
   1. Where shown on the drawings install a passive infrared motion-based request to exit device.
   2. Associate this with one or more doors so that when it senses motion it shunts the door contact.
   3. Wire this back to the panels in the comm. rooms.
   4. Install above the door.

C. Request to Exit Devices “RX” on drawings
   1. When the RX is shown, wire from this device in the lock/pushbar, back to the controller in the comm room.
   2. Set this up to shunts the door contact when triggered.

D. Embarrassment Alarm, “EA”. Shall be mounted to the wall or ceiling. Determine at location in the field.
   1. Provide raceway and backbox for the alarm.
   2. Wire to the security systems. This alarm shall engage for a set length of time when the lockdown button is pressed.
   3. Set the owner requested length of time. Test that the alarm goes off either when the contact is re-engaged or the time expires.

3.10 ASSISTED OPENER FOR ADA

A. Assisted Opener: “AO” and assisted button “AB” on drawings
   1. Where an assisted opener is shown the contractor shall wire to this opener and associated opener buttons (“AB”) to work as noted on the drawings and as below:
   2. Operation sequence when the doors are locked entering from outside -valid id card
      a. If the person presents a valid card then the latch shall retract inside the exterior door.
      b. The door shall hold unlocked for 15 seconds.
      c. The control board shall allow the exterior push button to be energized. Once the push button is energized then the exterior door shall be opened if the button is pushed.
   3. Operation sequence when the doors are unlocked entering from outside
      a. Push the ADA button Exterior door opens
   4. Operation sequence when the doors are locked entering from outside -no card or invalid card
      a. If the person pushes the exterior opener button, then the auto opener shall not engage because the opener button is not energized.
      b. The exterior opener button is not energized unless the PACS notes that the door is unlocked.
   5. Operation sequence when the doors are locked, exiting from interior
      a. When a person pushes the interior opener button then that shall communicate with the interior auto opener and open that door.

b. The control board of the auto opener shall communicate with the access control system and instruct it to retract the latch on the interior door.

6. Operation sequence when the doors are locked, exiting from vestibule
   a. When a person pushes the vestibule opener button then that shall communicate with the exterior auto opener and open that door.
   b. The control board of the exterior auto opener shall communicate with the access control system and instruct it to retract the latch on the exterior door.

3.11 FIELD DEVICES.

A. These devices shall be connected to the PACS and shall provide inputs or act upon outputs to accomplish their tasks.
B. Wire from each of these devices to the PACS
C. Configure each device as an input or receiver of an output.
D. Test each device.
E. Contact Closure “CC” or Security Contact “SC”
   1. This shall be either an input or output
   2. Use this connection to trigger the system at the other end or receive a trigger or contact closure from the other device.
   3. An input may set in motion multiple outputs. Configure each as per the owner’s requirements.

3.12 DEVICES AT THE OPERATOR DESK

A. These devices shall be connected to the PACS and shall provide inputs to the system. Setup actions that occur after the device initiates a trigger to the PACS.
   1. Work with the owner and configure the system to initiate or stop any devices based on the input from the device.
B. Wire from each of these devices to the PACS
C. Test each device.
D. Push Button “PB,
   1. Wire each button and each light if so equipped
   2. Provide the correct cable to support full use of the button or switch or control of the LED light
   3. Install the toggle switch on the desk or under the desk.
      a. Mount to a backbox with blank stainless steel plate if it is not possible to mount directly to a desk.
   4. Mount each device to the furniture at location identified by owner.
   5. Wire back to system. Configure system to have two or more states. One for each switch position. Talk to owner to identify the states required.
   6. Meet with owner to discuss how buttons shall be configured.
   7. Lockdown button shall have a light and it shall be lit when the system is in “LOCKDOWN”. When the lockdown button is reset the light shall go out and the entire system shall return to regular schedule.

3.13 INTERCOMS AT THE DOORS

A. IP Intercoms
   1. Intercom at the door shall be installed based on the type chosen and specified in specs and drawings.
   2. Where the Intercom is surface mounted.
      a. Surface mounted units shall be connected to the interior of the building with a conduit and steel backbox.
      b. Where possible route the cables through the door or wall framing and extend to the intercom.
      c. Install raceway from bottom of intercom to lower pushbutton.
      d. Ensure installation of lower button to meet ADA requirements
   3. Flush-mounted intercoms

a. Provide and install the custom backbox at the intercom location.
b. Provide notice to electrician to allow them to install conduits to accessible ceiling.
c. Review and ensure raceway from bottom of intercom to lower pushbutton is installed.
d. Ensure installation of lower button to meet ADA requirements

4. Wire the lower pushbutton to the intercom to support initiation of an intercom call
5. The intercom device shall be located at a place where it is accessible and where it can be mounted to see the person calling.
   a. Camera shall be positioned to cover the maximum area possible.
   b. Install a connection cable from the exterior interface to the interior unit and door lock.
   c. Install any baluns, adapters, or other devices required to send the signal from the exterior intercom to the network.
   d. Provide CAT-6 patch cables
6. IP Programmable Relay.
   a. This device shall be mounted in the main communications room.
   b. Connect to the Ethernet network with appropriate CAT-6 cabling
   c. Connect to the controllers to allow the base station to unlock the associated door.
   d. Integrate so that the base station only controls the door that the call was initiated from.
7. Base stations shall be located as shown on the drawings.
   a. The devices shall be configured to allow the Owner to unlock the door when a person calls in and is determined to be acceptable for entry.
   b. The master control devices shall interface with the access control system through the IP Programmable relay to interrupt any alarms and momentarily unlock the door.
   c. Configure they device to allow the user to determine which door the call is coming from and then unlock only that door.
   d. Provide all cabling and other equipment required to connect the base station to the Ethernet network. CAT-6 cable, Plenum Rated.

END OF SECTION 28 3500

SECTION 28 3600 – SECURITY RECORDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes parts and equipment required for installation and configuration of a video security system. This system shall be referred to as the “security system” throughout these specifications.

1.02 SYSTEM DESCRIPTION

A. The security system shall be supplied and installed by a Contractor able to show examples of similar projects and installations within the last 3 years.

B. The video security system shall serve the building(s) shown and be able to be expanded to support other buildings attached to the data network

C. New cameras shall be IP cameras with direct connection to Ethernet Switches.

D. Software and hardware shall allow for monitoring from any PC attached to the data network.

1.03 COORDINATION

A. Coordinate with the network contractor. Provide IP addresses and ports the cameras are connected to in an excel spreadsheet to the network contractor for VLAN configuration

B. Coordinate with data cabling contractor. Walk the site and identify all camera locations and make the cabling contractor aware of all camera locations.

1.04 PROJECT PLAN

A. The contractor shall provide a project plan to the owner and contractor that describes the system and its capabilities and the possible configurations.

B. Provide a project approach which describes the installation and implementation plan and schedule and all sequencing.

C. Meet with the owner numerous times to determine how the system should work and how it should be monitored. Configure the system prior to installation to meet these requirements. Demonstrate the system use to the owner prior to installation and obtain approval to move forward with the installation.

D. Provide shop drawings showing all configuration and connectivity of the system.

E. Generate a testing plan and have that plan approved by the owner and engineer prior to installing the system.

1.05 RELATED STANDARDS

A. The security system shall conform to the following international and national standards:

1. FCC Rules and Regulations
2. UL 294 Access Control Systems
3. UL 1076 Line Supervision
4. 21 CFR part 11
5. Part 15, Radio Frequency Devices
6. National Electrical Manufacturers Association (NEMA)
7. Applicable Federal, State and Local laws, regulations, codes
8. Americans with Disabilities Act (ADA)
9. National Electrical Code (NEC)

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved vendor for video security camera recording software is:

1. Digital Watchdog
2. No others are allowed

2.02 VIDEO MANAGEMENT SOFTWARE (VMS)

A. The VMS shall be Digital Watchdog.

1. Provide additional licenses to existing system to support new server.

2.03 VIDEO SECURITY HARDWARE

A. Network Video Recorder shall be Digital Watchdog Blackjack AI Server

B. Network Video Recorder (NVR):

1. The Contractor shall provide an NVR or multiple NVR's that connect to all the video cameras. Size the system to accept additional cameras to be installed in the future. See drawings and/or specs for quantity
   a. The NVR shall be a central control and storage system that allows the Owner to view and review images from any or all cameras.
2. NVR and associated storage shall be of the latest manufacture and software release available.
3. Shall supply multiple simultaneous playback streams.
   a. The system shall allow all PC's attached to the wired Ethernet network to view cameras at full resolution on their PC.
   b. Size the processor of the NVR and Monitoring PC to allow viewing of up to 32 cameras at the monitoring PC without any slowness or loss of signal.
4. The NVR shall be capable of continuous, schedule, alarm/event, and motion recording, shall have pre- and post-alarm recording and shall be fully programmable on a per-channel basis.
   a. Any motion sensing shall be assumed to be done at the server. Use this for servers sizing.
   b. See specifications below for recording parameters.
5. The NVR shall have expandable storage capacity to allow additional storage of video. The expandable storage shall be easily added and integrated into the system.
6. The network video recorder shall offer plug-and-play configuration for cameras.
7. The network video recorder shall provide performance enhancement and fault tolerance by employing RAID-5 style redundancy across multiple disk drives and shall feature a hot drive swap that automatically configures the drives when installed.
   a. Where the Video Management Software (VMS) requires, the Immediate recording shall be to High-Speed drives.
   b. Images can then be moved to slower, long-term storage devices.
   c. Provide these drives based on the VMS being installed.
8. The network video recorder shall meet or exceed the following design and performance specifications:
   a. Processor:
      A) No less than Two, Quad-core processors, Intel® Xeon 5600 series® 4, 2.8 GHz or equal.
      B) 64 Bit
      C) Provide calculations from the software manufacturer and camera manufacturer to prove processing and storage submitted will meet system requirements
      D) Provide the actual throughput and quantity of storage being provided and note how it meets calculations from the software manufacturer and the camera manufacturer.
   b. Internal Memory:
      A) 16 GB minimum.
   c. Operating System:
      A) Linux or Microsoft. (provide any operating system software)
   d. User Interface:
      A) Remote operation from standard Windows 10 PC's.
      B) Shall be equipped with web interface to allow viewing of live and recorded video through a standard web browser.

C) Shall allow and be equipped with software and hardware to allow viewing of live video on a tablet or smartphone device.

e. NVR throughput:
A) Server throughput shall be the capacity of the server(s) to process incoming live and recorded video. This shall be a function of the processing power of the NVR/server.
B) It shall provide for processing, live viewing, remote viewing and recording capacity to record on all cameras at:
1) 15 frames per second.
2) Constant recording of all cameras
3) Compression shall be no higher than 30%. Thus if full bandwidth of the camera is 100 then configuration shall be no less than 70 on a 1 to 100 scale.
4) 8 users viewing 16 cameras each
C) Thoughput shall be calculated at maximum camera resolution of the specified cameras. Throughput required shall be calculated for cameras that are part of this project plus to include fifty (50) future cameras at 3840x2160.
D) Throughput shall include processing of the cameras shown plus future additional cameras as noted on the detailed drawings.

f. Video image storage: This shall include the amount of disk storage space required to store all the images from the cameras. Storage space shall be calculated based on:
A) Recording images on all cameras at 15 frames per second,
B) Assume recording on movement rates of 40%.
C) Additionally, each camera shall record 1 frame per second when there is no motion.
D) Storage for 30 days.
E) Storage shall be calculated at maximum camera resolution of the specified cameras. Storage required shall be calculated for cameras that are part of this project plus to include fifty (50) future cameras at 3840x2160.
F) Include processing of the cameras shown plus future additional cameras noted on the drawings.

g. Total Capacity shall be calculated by Contractor. Provide calculations if you are asked to present your solution or if you are the chosen bidder.

h. Hard drives shall be internal or part of an external storage array. All discs shall be configured in a RAID 6 redundant style array such that losing any single drive will not mean a loss of recorded images.

9. Each NVR Shall have dual power supplies.

10. The NVR shall have One (1) 10 Gigabit Ethernet connection(s) via an RJ-45 copper or Fiber Optic type interface.
a. If the interface is a fiber Optic connection then provide the equal SFP module for the Ethernet switch that is being used to connect the Ethernet Switch

11. The NVR shall be 19 inches rack mountable.

12. The NVR Servers shall be supplied with no less than three years of 24x7 maintenance that includes next day replacement of drives and service on the server.

13. Servers shall be from the following manufacturers
a. Digital Watchdog BlackJack AI server

PART 3 - EXECUTION

3.01 EXAMINATION

A. Review site and note locations of cameras, conduits and cables prior to installation.

B. Review all ceiling styles on the reflected ceiling plans. Provide mounts as required based on the ceiling style.

3.02 INSTALLATION

A. The Network Video Recorder (NVR) shall be mounted in the Creek side Data Center.
   1. Mount the NVR in a cabinet/rack. Connect to the local area network as required for complete system connectivity.
   2. Connect the NVR and all cameras to the Ethernet network.
      a. No less than two Gigabit Ethernet Connections
   3. Connect the power supplies of the NVR to the UPS.
   4. After full configuration of the system the contractor shall copy the complete configuration to another of the owner's servers and shall provide a CD or USB drive copy of the configuration.
      a. Contractor shall keep a copy of the original configuration of the server and all cameras at their site.
      b. Provide the information to the owner on a CD or USB Drive.
      c. The backup of the configuration shall provide the owner an easy way to reconfigure the system in case of a total system failure or a new server installation is required.

B. Fully configure the Video Recording and Control Software.
   1. The Contractor shall meet with the Owner prior to installation of the system to discuss all aspects and abilities of the NVR and VMS and the attached cameras.
   2. The Contractor shall present all configuration options to the Owner to get their input and let them choose how the system is to be used and configured.
   3. The Contractor shall take information from the meeting and record that in meeting minutes. Provide copies of these minutes to the Owner and Designer
   4. The Contractor shall configure and install the system as requested by the Owner and as shown on the drawings and specifications.
   5. The servers and storage shall be configured based on the manufacturer's recommendations.
      a. Discuss drive array and recording processes with the owner and manufacturer prior to installation of the system
      b. Discuss recording block size with the manufacturer prior to installation.
      c. Meet with the owner and discuss the server(s) setup and present a document from the NVR software and server manufacturer to demonstrate how the system will be configured.
      d. Evenly distribute cameras and recordings across all servers.
   6. Configuration of the system shall include but not be limited to the following.
      a. Labeling of all cameras in the system to match the owner approved labeling scheme as well as their chosen specific descriptive name.
      b. Video blanking of any areas on each camera if there are areas that are not to be seen or recorded by the NVR system.
      c. Passwords and logins for users and administrators. Include in this a list of all the users and their access levels.
      d. Recording Frames per second, resolution and long term recording resolution.
      e. Generation and configuration of any presets for PTZ cameras including tours and timing.
      f. Specialized recording times for each camera including additional FPS or resolution at times of the day.
      g. Backup times and all data to be backed up. Configure scheduled backups
      h. Aiming, focusing and framing of all camera images.
         A) Sit with the owner and review each camera's view and custom set the aiming, framing and focus of each camera.

B) Have someone at the camera while reviewing that is able to move and aim and focus the camera.
C) Download an image from the camera as the owner wishes it to be aimed
D) Create a spreadsheet with each camera and have the owner sign off on the aiming of each camera.

i. Generation of custom views for all user software. Meet with each person that is allowed to view the cameras and help them generate a custom view of the cameras they wish to see.

7. Contractor shall fully load and match all maps to the video security system. Install all maps and load all camera locations and hot buttons to the maps to allow quick connect to the cameras based on clicking on the camera location on the map.
   a. Each camera button shall show the camera number.
8. Recorded images and offloaded images shall be able to be time-stamped with the date, camera number and exact time down to the second when the video was recorded.
   a. This shall be able to be seen on the viewing station and shall be attached to the video when it is offloaded and viewed on an outside player.
   b. Setup the server and software to obtain time from the national standard time.

C. Connect the storage to the new NVR servers and the rest of the servers.
1. Configure the storage to provide service to all users and all storage requirements.
2. Meet with the owner prior to installation and present all options to the owner in regards to the configuration options. Assist the owner in deciding which options best meet their needs.
3. Publish a plan and configuration parameters of the storage and ensure that everyone agrees with the plan.
4. Install the storage and connect to all servers.

D. Analytics Configuration.
1. Analytics may be in the VMS or at the camera. Contractor shall setup each camera that is able to provide analytics. Shall be setup on the camera and the VMS
2. Setup the system to support alerts and search of recorded video based on metadata collected thru the analytic.
3. Include time in the contract to work with the owner to determine which analytics shall be setup and on which cameras the analytic shall be setup.
4. Identify each camera and what analytics shall be setup.
5. Create a document that details the available analytics and on which cameras they are available.
6. Setup the analytic to alert the owner thru the VMS when a threshold setup is exceeded.
7. Setup the VMS to support search using metadata captured by the analytic.
8. Test the analytic at each camera and throughout the entire VMS for live and recorded video.

END OF SECTION 28 3600

SECTION 28 3700 – SECURITY CAMERAS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes parts, equipment and cabling required for installation of the video surveillance cameras.

B. This shall include new IP video cameras and their cabling/termination equipment as shown on the drawings and detailed in the specifications.

1.02 COORDINATION

A. All cables shall be coordinated with the installation of the raceways.

B. All cameras shall be installed in the ceilings in relation to the lights and other obstructions.

1.03 DESCRIPTON

A. Provide new IP cameras for video surveillance. See the detailed security drawings for location and quantities.

B. Cameras shall be pure IP cameras without the use of external encoders/decoders where possible.

C. Power for interior and exterior cameras shall be provided via the POE switch or via a centralized power supply in the communications room.

1. The switches installed provide standard Type 3 PoE (15.4 watts) on each port. If a camera requires additional power above Type 3 PoE then the contractor shall provide that power supply and any additional required power cables.

D. PTZ cameras that require additional power above that provided from a Type 3 PoE connections shall be provided with a power supply.

1. Provide any and all camera, power and control cables required for complete system connectivity and functionality.

E. It shall be the Contractor’s responsibility to provide all power to cameras based on the above methods. Take into account the Manufacturers recommendations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved Manufacturers for IP cameras:

1. Digital Watchdog

2.02 CAMERAS GENERAL REQUIREMENTS

A. Cameras shall provide full color images and some shall change to black and white in low light.

B. Cameras shall support text overlay of image in viewing to allow naming/numbering of each camera on the screen and when video is offloaded.

C. The Contractor shall review the site with the Owner prior to ordering the lens for each camera.

1. Finalize the needs of the Owner with the camera position to ensure that the correct lens is purchased for the camera.

2. Review actual installation location prior to ordering cameras. Purchase correct mount for camera. All cameras in drop ceilings or hard ceilings shall be installed with recessed camera mounts.

D. Where noted on the drawings, provide a vandal resistant dome to the camera.

E. Where cameras require more power than PoE 802.af then the contractor shall provide power to the camera from a centralized power supply in the comm. room.

F. External Cameras

1. Each exterior camera shall be equipped with a heater/blower or other device to keep camera functional and keep lens/casing from fogging or condensation from forming.

2. Provide mounts for exterior cameras based on their installation location. Provide fully enclosed mounts. See drawings and conduct a field survey prior to ordering to ensure that he correct mounts are provided.

a. Exterior mounts shall allow cable entry to the dome via the support. No cables shall be exterior to the mount or dome.

2.03 CAMERA -4K 180 DEGREE BULLET STYLE CAMERA -OUTDOOR

A. MEGApix Ai 4K Ultra-Wide Angle Pano Bullet camera
B. Shall include all mounts and hardware for indoor or outdoor installation
C. Camera shall include:
1. Star-Light Plus, 2.3mm ultra wide lens,
2. AI Deep Learning,
3. 1/1.8 Image Sensor,
4. Triple Codecs (H.265, H.264, MJPEG),
5. True Wide Dynamic Range,
6. 100ft Smart Infrared
7. Two Way Audio,
8. Micro SD/SDHCC/SDXC class 10 card slot(card not included),
9. PoE and 12Vdc power
10. Shall be ONVIF Profile S and NDAA/TAA Compliant,
11. Shall include a 5 Year manufacturer Warranty.
12. Camera shall be Digital Watchdog # DWC-XSBC08Bi
a. Exterior cameras shall be equipped with a heater and correct mount.

2.04 CAMERA -4K 180 DEGREE BULLET STYLE CAMERA -INDOOR

A. MEGApix Ai 4K Ultra Wide Angle Wall Mount Pano wall mount, indoor camera
B. Shall include all mounts and hardware for indoor installation
C. Camera shall include:
1. Star-Light Plus, 2.3mm ultra wide lens,
2. AI Deep Learning,
3. 1/1.8 Image Sensor,
4. Triple Codecs (H.265, H.264, MJPEG),
5. True Wide Dynamic Range,
6. 100ft Smart IR,
7. Two Way Audio,
8. Micro SD/SDHCC/SDXC class 10 card slot(card not included),
9. PoE and 12Vdc power
10. ONVIF Profile S and NDAA/TAA Compliant,
11. Shall include a 5 Year manufacturer Warranty.
12. Camera shall be Digital Watchdog # DWC-XSWA08Bi

2.05 CAMERAS 360 DEGREE -SINGLE SENSOR, INDOOR/OUTDOOR

A. MEGApix Fisheye Indoor/Outdoor Vandal Dome,
B. Shall include all mounts and hardware for indoor or outdoor installation
C. Camera shall include:
1. Star-Light Plus,
2. 9 Megapixel, 360 and 180-degree Panoramic view with Edge to Edge Clarity,
3. 1/1.7 Image Sensor at 30fps ,
4. Multi Codecs (H.265, H.264, MJPEG) with Simultaneous Dual Streams,
5. 80ft Smart IR,
6. True Wide Dynamic Range with Mechanical IR Cut Filter,
7. Two Way Audio,
8. Auto Gain Control (AGC), Auto White Balance (AWB), Motion Detection,
9. Micro SD/SDHC Class 10 Card Slot (card not included),
10. OnVIF Profile S, and NDAA compliant
11. IP66, IK9 rated
12. POE and DC12V,
13. Shall include a 5 Year manufacturer Warranty.

14. Camera shall be Digital Watchdog # DWC-PVF9Di2TW

2.06 CEILING OR WALL MOUNTE DOME 4K INDOOR/OUTDOOR CAMER

A. MEGApix IVA Indoor/Outdoor Vandal Dome Camera,
B. Shall include all mounts and hardware for indoor or outdoor installation
C. Camera shall include:
   1. Star-Light Plus, 4K ,
   2. Star-Light Plus, 2952x2320 @ 30fps,
   3. 2.8 Fixed Lens,
   4. Ai Deep Learning
   5. 100ft Smart IR,
   6. True Wide Dynamic Rante
   7. Triple Codecs (H.265, H.264, MJPEG) with Simultaneous Streaming,
   8. Two Way Audio,
   9. PoE Class 3 and DC12V power
   10. OnVIF and NDAA Compliant,
   11. Micro SD/SDHC/SDXC class 10 card slot (card not included)
   12. IP66, IK10 rated
   13. Shall include a 5 Year manufacturer Warranty.
   14. Camera shall be Digital Watchdog # DWC-XSDE08Mi

2.07 CAMERAS MULTI-SENSOR 180-270-360 DEGREE VIEWING

A. MEGApix 20 Megapixel Flexible Panoramic Indoor/Outdoor Vandal Dome (4 cameras in 1), 360 and 180 Panoramic View,
B. Shall include all mounts and hardware for indoor or outdoor installation
C. Camera shall include:
   1. Four (4) 5 MegaPixel (MP) Sensors
      a. Angle of view
      b. Horizontal Field of view (HFoV): 4x 51° ~ 93°
      c. Vertical Field of view (VFoV): 4x 39° ~ 68°
   2. 4x2.8-8mm varifocal motorized zoom lenses,
   3. 1/3" Image Sensors,
   4. Flexible sensor positioning with magnets,
   5. Triple Codecs (H.265, H.264, MJPEG) with simultaneous Dual Streams,
   6. True Day/Night with Mechanical IR Cut Filter,
   7. True Wide Dynamic Range
   8. Two Way Audio,
   9. Auto Gain Control (AGC), Auto White Balance (AWB),
   10. Motion Detection,
   11. Micro SD/SDHC Class 10 Card Slot (card not included),
   12. OnVIF Profile S and NDAA Compliant
   13. IP67 rated
   14. PoE Class 4 and DC12V PoE Injector to be Included, NDAA,
   15. Shall include a 5 Year manufacturer Warranty.
   16. Intelligent Video Analytics inside.
   17. Camera shall consist of multiple image sensors arrayed to provide a cohesive image in 180/ 270 degrees or 360 degrees or 270 degrees with one sensor facing down.
   18. Camera shall be Digital Watchdog # DWC-PVX20WATX

2.08 CAMERA ACCESSORIES

A. Camera Mounts:
   1. The Contractor shall provide all appropriate camera mounts. Refer to the drawings and conduct a site survey to determine each camera mounting type required.
      a. Complete this prior to ordering cameras.
   2. Exterior cameras shall be mounted to the wall of the building in most cases.

a. Where the camera is to look along the wall of a building the contractor shall provide an arm/pendant mount that mounts the camera parallel to the ground.
b. Mount shall extend the camera out from the building a few inches to allow viewing in 360 horizontal degrees
c. Corner mounts shall be installed where the camera is shown to be corner mounted.
1) Provide flexible raceway to extend cable from the building or backbox and into the

3. The security cameras shall be mounted to building structure where shown on the drawings.
a. Contractor shall provide a mount that best corresponds to the structure and can be securely mounted.
b. Mount the camera at a height as shown on the drawings or at the optimum height to allow the best field of view and future service via extension ladder.
1) Unless specified the cameras on the exterior of a building should not be installed more than 15’ above grade.
c. When mounting the cameras, take into account the light and mount the camera so that it does not block light.
d. The camera mount shall provide a route for cables extending from the raceway to the camera. Cables shall not be installed outside the camera dome or camera mount.
e. The Contractor shall install a conduit to allow cable installation to the camera.
1) This shall include installing conduits from the inside of the building to the outside of the building to support exterior cameras.
2) Core through the outside of the building. Coordinate location with owner and architect prior to drilling.
3) Install ¾ conduit or sized as per the mount.
4) Except for corner and parapet mounts no conduits shall be visible after installation.
5) At no time shall a cable be visible. Install flexible conduit and seal appropriately around holes made in the building
6) Repair wall after installation.
7) No cable shall be visible after camera installation.

4. Dome-type cameras interior to a building may be installed in the lay-in ceiling.
a. Provide supports so that the camera’s weight is supported from the “T” bars of the drop ceiling.
b. Provide a backbox and escutcheon to make a tight fit from the dome to the drop ceiling tile.
c. Locate the cameras to cover the area required by the Owner. Work with the Owner prior to installation.

5. Dome-type cameras interior to a building may be installed as a pendant mount from the building structure.
a. Provide a backbox at the building structure. Install a downpipe and camera mount to attach the camera to the downpipe. Size the pipe as required.
b. The camera mount shall keep the camera level and shall extend down to a level of no more than 11’ AFF.
c. Locate the cameras to cover the area required by the Owner. Work with the Owner prior to installation.

6. Dome-type cameras interior to the building may be required to be mounted to a wall.
a. Where there is a wall mount requirement, the Contractor shall install a wall-mount. Ensure that it is securely mounted.
b. Route the cable through the wall and through the mount to connect to the camera.

B. Camera accessories.

1. Contractor shall provide and install any and all accessories required for complete mounting, configuration and power delivery.
2. Pendant NPT adapter Avigilon #H6A-MT-NPTA1
3. Pendant wall arm, 1.5" NPT female, 20 cm (7.8") long Avigilon #WLMT-1021
4. In-Ceiling adapter Avigilon #CLADP-1001
5. Metal ceiling panel for suspended ceiling installations Avigilon #CLPNL-1011
6. Weathershield for dome cameras Avigilon #DMSLD-1001
7. Camera sealing grommet, pack of 1 Avigilon #0GROM-1001
8. Pipe sealing grommet, pack of Avigilon #10GROM-1011
9. Pole mount adapter Avigilon #PLMT-1001
10. Corner mount adapter Avigilon #CRNMT-1001

2.09 CAMERA INSTALLATION ACCESSORIES

A. Firestopping shall be completed inside and around all conduits after cable installation. Contractor shall install the best firestop for each individual installation.
   1. Firestop shall be installed with regard to local and national building codes.
   2. The firestop shall be a putty-like substance that expands under heat and will not allow flame to pass for a designated period of time.
   3. Firestop shall conform to all NEC, NFPA, and UL requirements.
   4. Some wall pass-thru's are shown on the drawings. The Contractor shall utilize these where possible.
   5. Where the contractor must install cables through a wall where there is no pass-thru already provided, the Contractor shall be responsible for installing a fire-rated pass-thru and fire-stopping the conduit after cable installation.

B. Weatherproofing shall be completed inside and around all conduits supporting exterior cameras after cable installation. Contractor shall install the best weatherproof for each individual installation.
   1. Weatherproof around all conduits that extend through the building to the cameras on the exterior wall or soffit.
   2. Seal all cameras so that all camera housing does not allow water into the conduit or into the building.
   3. Seal so there is no infiltration of water or condensate.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine all pathways prior to installation of all cables.
B. Identify locations of all user conduits and backboxes prior to cable installation.
C. Review site and note locations of cameras and conduits prior to installation.

3.02 PREPARATION

A. Visit each camera installation location to verify the type of mount prior to ordering the cameras.
B. If another contractor is installing the CAT-6 cabling then the contractor shall coordinate cable location with that contractor.
C. Green Tape walk thru.
   1. Contractor shall walk the entire site with the owner and identify each camera location with the owner prior to installation.
   2. Discuss the type of camera and its proposed field of view.
   3. Make adjustments as required by the owner and by the building structure to minimize interference and blocking of the camera image.
   4. Install a piece of green tape on the wall or ceiling at each camera location after agreement on the location is reached.
   5. Remove green tape after installation of cameras
D. Camera naming spreadsheet.

1. Create an Excel spreadsheet showing the following:
    a. Camera number
    b. Camera part number
    c. IP address
    d. MAC address
    e. Owners chosen camera name
    f. Provide to the owner and designer.

3.03 INSTALLATION

A. Each camera shall be installed to provide maximum field of view and security.

B. Exterior cameras shall be mounted securely to the structure and shall be sealed to prevent water or any other environmental condition to enter the camera.
1. Provide the correct mount for the location of each exterior camera.
2. Where the mount is to the outside of a building then the contractor shall install a conduit from the exterior camera to the inside of the building for the camera cable(s).
3. Review mounting location to determine optimum height of camera to cover all areas and provide the clearest pictures. Mount at appropriate height.
4. Work with the Owner to focus and align all cameras for maximum coverage.
5. Contractor shall change lenses for different focal lengths based on the actual installation location of the cameras and the requirements of the Owner.
6. Seal around all conduit openings and the camera mount to seal from water and air infiltration.
7. Install patch cable through the conduit and connect to the CAT-6 cable on the interior of the building.

C. Interior cameras shall be mounted in the lay-in ceiling, supported from the open ceiling or to the wall with a structural mount.
1. The Contractor shall work with the Owner to determine the location of all the cameras.
2. Work with the Owner to determine the direction of the lens and its focal length.
3. Ensure that the camera is mounted securely to the drop ceiling and is supported from the T-bar.
4. Where interior cameras are mounted to the wall, the Contractor shall provide a mount that will allow all cables to route through the mount. Cables shall not be “free-floating” from the wall to the camera.
5. When a camera is pendant mounted the contractor shall install a down-pipe and conduit support to mount the camera at the correct height as determined by the owner.

D. Camera obstructions
1. Prior to camera installation review the site and make sure to install cameras so there are no obstructions such as lights, ducts, EXIT signs etc. that will obstruct the camera view.
2. Provide additional pipe and threaded rod as required to mount camera so there is no obstruction of the view.
3. Install at height or location so that the camera sees the entire field of view.

E. Contractor shall focus and aim all cameras
1. Camera aiming and focusing shall be a process where the owner has input at each stage.
2. The process for aiming and focusing shall be as follows:
    a. Meet with the owner and determine the desired view of each camera. Determine where images shall overlap and what they are focusing etc.
        1) Add this information to the camera naming spreadsheet.
    b. Install the cameras and aim as per the meeting notes.
    c. Meet with the owner and review each camera view on the monitor. Make notes of any changes required.
    d. Schedule a time to make all changes.

1) Changes shall be made while the owner is reviewing the live image through the VMS Software. The contractor shall have a person at the camera that can aim and focus the camera.
2) Once the owner agrees on the image aim and focus generate a still picture of that image and keep it in a file.
3) Print the aimed view and provide as part of the submittal at project substantial completion.

F. Camera naming
1. The contractor shall work with the owner and engineer to determine the naming and numbering convention for the cameras.
2. Determine the naming and then apply that to each camera. Enter the designation of the camera into the video security system.
3. On all cameras the contractor shall affix a label with the camera number to the exterior case of the camera. This shall be visible when standing near the camera.

END OF SECTION 28 3700

SECTION 28 5401 – FLAT PANEL VIDEO DISPLAYS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Parts and equipment required for transmitting, switching, generating and viewing video images.

B. The words LCD, Display and Flat Panel display shall be used interchangeably and shall refer to a flat panel display that has LED or OLED lighting or is a direct view LED display.

1.02 SYSTEM DESCRIPTION

A. Each LCD Display, or projector shall be installed so that users can easily view the picture being presented.

B. The video systems shall be installed to provide the easiest user interface possible.

1.03 COORDINATION

A. Coordinate the location of all LCD Displays, and projectors with the Owner and other trades prior to final installation.

B. Coordinate with other Contractors who are doing work in the ceiling space. Coordinate the installation of all cables, projectors, monitors, etc., with the locations of other services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved vendors for video displays are:
1. Samsung
2. Panasonic
3. LG
4. Epson
5. NEC

2.02 LCD DISPLAYS

A. LCD Display -450+cd/M (NIT Brightness)
1. Specified for 18/7 runtime
2. Displays shall be 16:9 and shall include speakers
3. Display shall be an LCD screen with LED backlight
   a. Minimum 350 cd/M²
4. Display shall be able to show images at 480i, 480p, 720p and 1080p and 4K
   a. Minimum pixels of 3840x2160
5. Inputs shall be a minimum of:
   a. HDMI x3
   b. USB-C x1
   c. Ethernet LAN 1000MB
   d. USB-A x3 1 for Downstream, 2 for Media/Peripherals
6. Outputs shall be a minimum of:
   a. Optical Audio out
   b. 3.5mm audio
7. Control
   a. Shall have an RS-232 and IR. Each display shall include a remote control.
8. Speakers.
   a. Shall be two speaker with minimum 10 Watts each.
9. Shall have Wireless LAN Connectivity
10. When using a 3rd party control system, the contractor shall provide and install the connectors and cabling required for RS-232 control.
11. Displays capable of 4K shall be
   a. 65” LCD Display UHD shall be SHARP #PN-ME652 or equal

B. LCD Touch panel. Interactive display
1. LCD Display shall be installed as shown on the drawings.
2. Displays shall be 16:9 and shall include speakers
3. Display shall be an LCD screen
4. Display shall be 3840 x 2160
5. Video/audio input shall be a minimum of:
   a. Display Port
   b. PC input, 15-pin D-sub
   c. PC audio (3.5 mm)
   d. HDMI Input. Minimum of two (2)
6. Output of Analog audio on 3.5mm connector. Shall be variable level output.
7. Control
   a. Shall have an RS-232 input/output for control.
   b. Shall be equipped with Ethernet 10/100Mbps connection
   c. USB for connection of interactive PC
8. Equipped with VESA compatible mounting holes
9. Display shall be no thicker than 4-1/2 inches.
10. Equipped with internal audio speakers. Minimum of 2.
11. Each display shall include a remote control.
12. Include WIFI dongle for each display
13. Display shall be an interactive touch panel that includes at a minimum:
   a. Shall work with Windows PC's and Apple IOS
   b. Touch technology shall be IR Blocking or equal
   c. Shall allow up to 10 points of contact
   d. Shall be adaptive to work with finger touch or mfg. pens
   e. Include interactive software that on the display and that can be loaded on the PC or Apple device
14. Touch panel display shall be NEWLINE. Include minimum 3-year manufacturer warranty
   a. 86" Diagonal shall be Newline #TT8623C

2.03 FLAT PANEL MOUNTS

A. Flat panel Mounts
1. All supports for LCD panels and monitors shall be appropriately sized and chosen for the exact model display to be supported.
2. Contractor shall match the weight of the display to the recommended weight rating of the support.
3. Contractor shall review the location where the support is to be mounted. Match the surface to which the display is to be mounted with the best attachment hardware available for the support.
4. All supports shall be by Chief Corporation or equal. Contractor shall submit each support for review by the Owner and Engineer prior to installation.
5. Wall Mount swing out
   a. Wall mount Tilting mount shall be
      1) Chief Mfg. #LTM1U for large displays
      2) Chief Mfg. #XTM1U for extra-large displays
      3) Install based on manufacturers recommendations, based on size of Display.
6. Flat panels rolling mount.
   a. The rolling mount shall be able to support a flat panel and associated PC and shelf.
   b. Rolling mount shall be equipped with casters.
   c. Mount shall be able to support up to a 86" LCD.
   d. Mount shall be Chief #PFCUB or equal.

B. Flat Panel accessories.
1. Component Storage Panel behind display
a. At each display where there are devices to be installed behind the flat panel display, install a component storage panel.
b. Hide panel and all components behind the display.
c. Shall be Chief #CSMP0X12 or equal.

2.04 HDMI TO UTP TRANSCEIVERS
A. HDMI and USB-C to UTP transmitter and receiver. Includes USB-C
1. Systems shall transmit HDMI 2.0 and USB 2.0 via CAT-6A cable.
2. Supports distances of up to 230 ft (70 m) for 1080p output or up to 130 ft (40 m) for 4K60Hz HDMI and 4K30Hz USB output.
3. Shall be HDCP 2.2 compliance ensures secure connections between source and display.
4. Transmitter shall support HDMI and USB-C input on a faceplate for single-gang backbox
a. Shall include an input choice button on the plate
b. USB-C port shall support 4K 30Hz video transmission via DP Alt Mode (v1.2a) and USB 2.0 data transfer
5. Shall support bi-directional RS-232 via Captive Screw connector
6. Receiver shall be mounted behind the display and shall support
7. Two (2) USB-A ports with up to 5V/1.4A output, accommodating high-bandwidth devices like cameras.
8. HDBase-T shall be via RJ-45 at faceplate and receiver.
9. Install plenum rated, CAT-6A cable to connect between transmitter and receiver
10. Power transmitter from the display end



11.
12. HDBaseT Extender faceplate and receiver shall be C2G # C2G31029 or equal

PART 3 - EXECUTION

3.01 EXAMINATION
A. Location of the video mounts shall be finalized throughout the building prior to installation.
B. Locate all equipment to be installed and make certain that space is available for maintenance and service during the life of the system.
C. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the displays to the Engineer for approval prior to installation.

3.02 PREPARATION
A. Ensure that the wall where a display will be mounted can support the weight of the mount and the display.

1. Work with other contractors to ensure they are installing Blocking in the walls for the LCD's
2. Where no blocking is available, provide and install metal stud anchor kits from display mount contractor.

B. Coordinate with the Lighting Contractor on location of all displays. Ensure that lighting will not impede the viewing of the image.

C. Coordination with other Trades:
1. The Contractor shall meet with the Electrical Contractor prior to installation of the security conduits and boxes to ensure that the boxes to be installed by the Electrical Contractor meet the requirements of the security camera system.
2. Coordinate power requirements in the communications room with other trades that will be installing equipment in the communications room.
3. It is the responsibility of the Contractor to install additional pass-thru's if required for the installation of their work. Fire-stop each pass-thru according to code requirements.

3.03 GENERAL VIDEO INSTALLATION

A. The entire video system shall be configured to be a complete working system.
1. Each cable shall pass the required video and audio signals.
2. Each display device shall be fully connected to all inputs and control cables.
3. Each display and signal processor and video source shall be set to maximize the video transmission and image quality so that they match the resolution.
4. Test each input on each display.

B. Provide all hardware and installation materials to support the video display devices.
1. Install custom unistrut and custom threaded rod from building structure to support all display devices

C. Each component shall be labeled for what it does and what it provides. Labels shall be laser-printed, and shall be attached to the front of each unit.

D. LCD Display mounts:
1. Each display that is to be ceiling or wall mounted shall have a UL listed mount.
2. Contractor shall match the display with the manufacturers recommended mount.
3. Verify that the mount is rated to support the weight of the display.
4. Install all mounts so that the display is not located in a main traffic way where persons might injure themselves by running into the mount or display.
5. Ensure that the mount can support the weight of the display, and that the wall can support the combined weight of the display and the mount. Secure to the wall using appropriate supporting screws and lugs.
6. Where attaching to a drywall wall, attach through or into the stud and not just through the drywall.
7. When ceiling mounting an LCD, provide the required length of pipe extension to meet the desired height of the display.
8. Contractor shall ensure the safety of all persons by securely installing the correct mounts for each display.

3.04 FLAT PANEL DISPLAY INSTALLATION

A. Flat panel display installation:
1. Displays shall be installed where shown on the drawings. Contractor shall field verify the location of all displays prior to final installation.
2. When mounting the displays to the wall, the Contractor shall verify that the mount is the correct size, and will support the weight of the display.
3. When mounting the display from a drywall wall, the Contractor shall connect into or through the wall studs. Attachment just into the drywall is not acceptable.
4. When mounting the displays to the wall, locate them to minimize the possibility that they will be in the path of persons walking near the unit.
5. Contractor shall verify ADA compliance with the installation of all projectors and displays.

6. The display shall be connected to the source via patch cables. The Contractor shall provide and install all patch cables required.
7. Contractor shall test that the display works with the inputs, and that the remote control (if applicable) has batteries and works with the system.
8. Contractor shall set up the display so that the picture is clear and set the correct color, brightness, contrast, etc. Install all display items so that glare from natural or manmade light is minimized for all those that will view the display.
9. When mounting the display, the Contractor shall ensure that it is installed and secured to minimize the chance of falling and causing possible injuries.
10. Contractor shall set up a time to review the installation with the Owner and Engineer. During the review, the Contractor shall demonstrate that each display works and is installed safely and securely.
11. When LCD is controlled with a control system provide all cables and test all control of the display.

B. Interactive flat panel installation
1. Mount the LCD to the Mount and to the wall.
2. Connect to all inputs and outputs
3. Provide additional hardware and supports to mount all equipment noted to be mounted behind the LCD.
4. Connect the LCD to the power and USB and HDMI cable to the display.
   a. Connect the Ethernet network cable with a patch cable if the LCD is so equipped.
   b. Identify the cable and the port it is connected to in the Ethernet switch.
   c. Enter this data into a spreadsheet and provide to owner or network contractor for configuration of the Ethernet ports.
   d. Provide and install patch cables at flat panel and at the comm room.
5. Set the contact points on the display for the interactive portion of the screen. Set all points and configure the “pens”
6. Load all interactive software on the teacher’s PC.

3.05 UTP AUDIO AND VIDEO TRANSMITTERS AND RECEIVERS.

A. The UTP devices shall be used to transmit the signals for the various displays.
B. Install all cables required to transmit signals from source to display output. Provide all patch cables for complete connectivity.
C. The transmitter shall be connected to the source device as shown on the drawings. The contractor shall make all audio and video connections.
D. At each display the contractor shall configure the receiver to compensate for any skew of the signal.
E. Connect the audio and video outputs of the receivers to the video displays.

3.06 TESTING (PRE-COMMISSIONING)

A. All systems shall be initially adjusted and set by the contractor, unless otherwise specified, in writing, by the Consultant or the architect.
B. A complete mechanical and electronic inspection to verify proper installation and operation shall be made, including mountings, interconnection, video scaling and sizing. Test procedures and documentation of results shall be provided with the system documentation.

3.07 COMMISSIONING

A. The video Contractor will provide a technician to assist the Consultant during the commissioning of the system. The technician will be ready and available to make any necessary adjustments or repairs to the system that the Consultant finds in error of the specification.
B. The Video Contractor will have on hand all installation documentation and equipment manuals. The Contractor will have the necessary tools available for any adjustment or

repairs. Once the system is commissioned, the Contractor will provide final As-built documents to the Consultant for review.

END OF SECTION 28 5401

SECTION 28 5450 – AUDIO EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES
- A. Parts and equipment required for audio enhancement and distribution.

1.02 SYSTEM DESCRIPTION
- A. The audio system shall be installed and configured to provide maximum coverage in each room.
- B. The audio systems shall be installed to provide the easiest user interface possible.

1.03 COORDINATION
- A. Coordinate the location of all racks, cabinets, and equipment with other contractors.
- B. Coordinate with other Contractors who are doing work in the ceiling space. Coordinate the installation of all cables, speakers, etc., with the locations of other services.

PART 2 - PRODUCTS

2.01 AUDIO AMPLIFIERS
- A. Large Ethernet attached audio Amplifiers:
  1. The power amplifier shall be a four-channel network-processing device that is designed to operate exclusively with a QSC q-sys ecosystem on a gigabit ethernet network.
  2. The amplifier shall be powered by a universal switch-mode power supply that supports operation at any ac voltage from 100 to 240 v at 50 or 60 hz.
     a. The amplifier shall be cooled by forced air, with the intake at the rear and exhaust at the front. The fan speed shall be thermally controlled and also shall be visible in units of revolutions per minute (rpm) on the amplifier's front panel as well as on its network control panel.
  3. The amplifier shall utilize a class d output circuit topology with four individual channels (a through d) providing up to 8000 watts (maximum short term) total power and 4800 watts (continuous) total power.
  4. The amplifier outputs shall utilize a technology called flexamp™, which provides up to 4000 watts of power to each pair of channel outputs, to be apportioned between themselves as needed. The outputs shall also utilize flexible amplifier summing technology™, which allows multiple channel outputs to also be combined in series (i.e., bridged) and/or parallel.
  5. The amplifier shall be configurable via q-sys, including arranging the output channels as single units as well as in various bridged and parallel combinations. The amplifier's audio signals shall originate in the q-sys ecosystem and shall also be configurable in q-sys.
  6. The power amplifier shall have no analog audio inputs, but only shall receive audio streaming data from the q-sys ecosystem.
  7. The power amplifier shall meet the following performance criteria:
     a. typical distortion (into 8 ohm loads) of 0.02% to 0.05%;
     b. maximum distortion (4 to 8 ohms) of no worse than 1%;
     c. a frequency response (into an 8 ohm load) of from 20 hz to 20 khz at ±0.25 db; noise at -104 db (a weighted, with output section muted); ihf damping factor of greater than 100.
  8. Channel muting and gain shall be controllable via the amplifier's front panel controls or the q-sys ecosystem. Changes made either way shall immediately reflect in the other as well. The amplifier shall indicate network status and monitoring, including faults. The front panel shall offer a summary of fault and error conditions.

9. The amplifier shall have output load monitoring on each output. The load monitor shall have the range to detect and calculate impedance of conditions including short circuits, low impedance loudspeakers, and lightly loaded 70 v and 100 v lines with impedances as high as 1 kω.
10. The amplifier rear panel shall feature dual rj-45 jacks for connecting to the QLAN network, enabling integration into the Q-SYS ecosystem for bi-directional passage of digital audio, control signals, and status monitoring data. T
11. he rear panel shall provide four 3-pin phoenix connectors for the balanced analog audio inputs (for mic or line signal levels), and four touch-proof phoenix connectors for connecting loudspeaker cables to the channel outputs.
12. The multi-channel system-processing amplifier shall be the QSC #CX-QN series.

2.02 AUDIO MIXERS / DIGITAL SIGNAL PROCESSORS

A. Multi-Channel, Multi-Function Signal Processor

1. The device shall provide MIC and balanced line-level inputs and line-level outputs. The inputs shall be 100% controllable via software, including gains.
2. The system processor shall provide up to 160 x 160 networked audio channels, individually configurable as either Q-LAN, AES67, or Dante formatted networked audio.
3. Shall include 8 x 8 Software-based Dante network audio channels and shall be licensable for up to 64 x 64 Software-based Dante capacity.
4. The system processor shall support 24 total analog I/O inputs/outputs and shall be presented in the following groupings:
   a. 8 Mic/Line inputs,
   b. 8 Line outputs and
5. The system processor shall be capable of connecting to any host PC, Mac or embedded device via USB and will present itself as up to four virtual external sound devices, each offering Speakerphone (with or without Acoustic Echo Cancellation) or a Soundcard plus a single USB Webcam for Soft-Codec conferencing and other applications.
6. The system shall perform all its real-time audio, video and control processing using Intel processors running a purpose-built, real-time Linux operating system
7. The system processor shall operate natively on a standard gigabit Ethernet infrastructure and shall employing DiffServ quality of service, IGMP, IEEE 1588-2008 (PTPv2) precision time protocol, UDP/IP audio and video transport with floating-point format audio data representation.
8. The system shall support 802.1x authentication.
9. The system shall not require IEEE 802.1AS, IEEE 802.1Qat, or IEEE 802.1Qav support on the network infrastructure to function.
10. The overall system latency from analog input to synchronized analog outputs anywhere on the network shall be 3.167 ms.
11. The system shall also be able to achieve an overall system latency of 3.167 ms over Layer-3 routed network infrastructure without any additional hardware, software or connection services between subnets.
12. The system processor shall manage external control interfaces such as
    a. Touchscreen Controllers,
    b. Paging Stations,
    c. Networked Audio I/O Expanders,
    d. Network Connected Amplifiers,
    e. AV-to-USB Bridging interfaces
    f. IP-based PTZ Conference Room Cameras.
13. A web interface shall provide basic network, services, and security configuration, status, and log retrieval. The system processor shall be natively integrated into

Designer Software for network discovery, real-time configuration, control, monitoring, supervision, and management.

14. On the rear panel, the system processor shall minimally include:
    a. Two (2) 3-pin RS232 Euro Block connectors,
    b. Two (2) USB Type-A Device ports to provide USB HID Bridging functionality,
    c. One (1) USB Type-C Device port to provide AV-to-USB Bridging capability
    d. Four (4) RJ45 connectors for Q-SYS Network functions.
15. The system processor shall offer up to 24 channels of built-in configurable Acoustic Echo Cancelation at the default tail length of 200 ms
16. The system processor shall store, and operate from, a single design that shall be comprised of audio, video, and control components, wiring, links, text, and graphics on a single or multiple schematic pages.
    a. Designs shall include any of the following audio DSP, video, test and measurement components, control components, and layout components:
        1) Acoustic Echo Cancellers, Audio Players, Audio Streaming components, Crossfaders, Crossovers, Delay components, Auto Gain control elements, Compressors, Gates, Duckers, Expanders, Ambient Noise Compensators, Limiters, Gain blocks, Graphic Equalizers, Parametric Equalizers, FIR Filters, All-Pass Filters, Band-Pass Filters, Band-Stop Filters, High-Pass Filters, Low-Pass Filters, FIR High-Pass filters, FIR Low-Pass Filters, Dual-Shelf Equalizers, Notch Filters, Meters, Matrix Mixers, Gain-Sharing Automatic Mixers, Gated Automatic Mixers, Signal Routers, Public Address Routers, Room Combiners, Signal Presence Meters, SIP Softphone instances, Tone Generators, Noise Generators, Dual Trace FFT Measurement Modules, Real Time Analyzers, Signal Injectors, Signal Probes, Logic, Value and Position control functions, Lua scripting components, Command Buttons and Triggers, Camera Router, USB Audio Bridge, USB Video Bridge.
17. The system processor shall support custom user control interfaces on either proprietary touch screen controllers, network computers utilizing a control application, iOS devices, or any device with a standard web browser.
18. Mixer/DSP/AV Controller Shall be QSC Core 24f or equal

B. TOUCHPANELS
1. Include the following accessories for this system.
    a. 10” Touchpanel control shall include:
        1) Capacitive touch technology
        2) Wall or desktop-mount, 12”, 1920 x 1080 LCD Panel with anti-glare safety glass
        3) Connection shall be an Ethernet 10/100/1000 Mbps connections
        4) Shall host a custom designed touch control interface for the QSC Q-SYS system.
        5) Shall be equipped to control and monitor the audio and possibly video system
        6) Capable of displaying custom bitmapped graphic images,
        7) Powered via PoE (Power over Ethernet) for singlecable connectivity
        8) Wall mount touch panel shall be QSC #TSC-101-G3 or equal
        9) Where required include a desktop mount.

C. AUDIO DSP ACCESSORIES
1. Bluetooth and Combo input plate
    a. Provide and connect a faceplate/combo device for Bluetooth Connectivity and 3.5mm audio input.
    b. Shall be Network attached and PoE Powered.
    c. Two-gang plate with GFI Style openings. Provide custom cover plate.
    d. Shall be Dante enabled and connected to the DSP device.

e. Setup the Bluetooth passwords for the owner.
f. Combo Plate shall be QSC #unD610-BT-White

D. Ethernet Switch
1. Provide a rack mounted Ethernet switch in the audio/video system that supports routing and distribution of Audio and Video Signals throughout the system.
2. Switch shall be:
a. Rack mounted and powered from 120 volt power
b. Capable of PoE+ output for most ports
c. Equipped with a power supply to support PoE+
d. Equipped to support Dante Digital Audio distribution
e. Video over IP Signal distribution
3. Ethernet switch shall be QSYS #NS26-480+ or equal. Size as required to drive all equipment.

2.03 AUDIO DEVICES
A. Provide and install Line Level Audio Distribution Amplifier.
1. RDL Labs #ST-DA3
2. Equip with power supply, RD Labs #PS-24AS
B. Audio extenders via UTP cable.
1. Provide sending and receiving devices to send and receive audio signals via UTP cable.
2. Provide and install all UTP cables.
3. See drawings for transmitters and receivers. Provide a complete system.
4. Where faceplates are to be provided, equip with coverplates.
5. Install a receiver for the sending unit and connect as an input to the audio system.
6. Install cabling from the receiver to the sending unit.
7. Connect to one of the ports on the audio mixer/dsp.
8. All cabling shall be plenum rated
9. Transmitters:
a. Rack or Wall mounted Line level audio to CAT-6, Active shall be RDL #TX-TPS1A or equal
10. Receiver shall accept the UTP cable and provide line level output to the mixer or DSP.
a. Provide receiver that matches the number of input plates.
b. Single line receiver shall be RDL #TX-TPR1A or equal.
c. Equip with power supply, RDL #PS24AS or equal.

2.04 WIRELESS MICROPHONES
A. Wireless Microphone Kits:
1. Wireless systems shall be based around the Audix R41 or R42 series receiver.
2. Equip with the following where required.
a. AUDIX Antenna Amplifier/Distro for System #ADS48
b. AUDIX External, Remote Directional Antenna #ANT-D360
c. For antenna cable to remote antennas, use Belden RG6 UHF Cable #1829A for ANT-D360 Antennas
d. Mount the Remote antennas up at the red iron to cover the entire room
3. Wireless Receiver shall have two channels or provide multiple single channel receivers.
a. 32 MHz Wide spectrum tuning receiver
b. 106 Pre-coordinated frequencies
c. Up to 4 systems (8 channels) simultaneous use
d. 21 dB Audio gain stage in 3 dB steps
e. Internal antenna combiner for dual antenna operation
f. 300’ (91 meters) Operating range
g. 19” Rackmount chassis with front mount antenna kit shall be included
h. Dual Channel Receiver shall be Audix R42 or equal

4. Bodypack shall be:
    a. 64 MHz Wide spectrum transmitter
    b. Precision metal housing
    c. Modular antenna design
    d. May be used with lavalier, head worn and instrument mics
    e. AF and RF gain control
    f. High contrast LCD display with group, channel and battery indicator
    g. Soft mute switch
    h. 10 Hour run time - AA batteries
    i. Provide (3) three sets of batteries
    j. Shall be Audix B60 or equal. Shall be compatible with receiver
5. Wired/Head worn wireless microphone shall consist of:
    a. (1) Audix #HT2 Professional head worn Microphone with Supercardiod capsule or equal
6. Lavalier wireless microphone. It shall consist of:
    a. (1) Audix #L5 Professional Lavalier Microphone with Cardioid capsule
7. Handheld wireless mic/transmitter shall be
    a. 64 MHz Wide spectrum transmitter
    b. Durable metal housing
    c. AF and RF gain control
    d. Modular and interchangeable capsule assemblies
    e. High contrast LCD display with group, channel and battery indicator
    f. Soft mute switch
    g. 10 Hour run time - AA batteries
    h. Shall be Audix #H60 or equal.

B. Wireless Microphone Extension Antenna.
1. Where required the contractor shall install an antenna in the room where the microphones are to be use.
2. All cabling shall be plenum rated unless noted otherwise.
3. When more than 1 wireless microphone will be used in the same room and the receivers are to be installed in a rack or cabinet, the Contractor shall provide an active antenna combining unit.
4. The antenna combiner shall be rack mountable.
5. Provide the correct antenna extension kit with the active combiner to place the antennas in the same room as the transmitter.

2.05 WIRED MICROPHONES

A. Wired microphone for handheld use shall have the following characteristics:
1. The microphone shall be equipped with a lockable ON/OFF switch and an internal impedance selection socket located on the XLR connector for switching between high and low impedance. A slip in swivel adapter shall be supplied for the convenience of stand mounted use.
2. Controlled low frequency response combined with a smooth high frequency rise for clear and intelligible voice pickup.
3. Hypercardoid pickup pattern for minimized feedback.
4. Spherical grille shall provide effective filtering out of breath noise and popping when used for close up vocals, and of wind noise when used outdoors.
5. Lockable ON/OFF switch.
6. Equipped with a 3-pin professional audio (XLR) connector.
7. Frequency response shall be 50 to 18,000 Hz.
8. Wired, handheld microphone shall be Audix #OM3 or equivalent.
    a. Provide a 25-foot microphone cable with each microphone.

2.06 RACK AND CABINET ACCESSORIES

A. Surge Protection and power strip.

1. This device will provide the only power on-off switch for the sound system.
2. All equipment mounted in the rack will be connected to this device.
3. No electronic device shall be powered from any non-protected power source
   a. SurgeX, # SX1120RT 20A/120VAC;

B. Rack Mount drawer:
1. Drawer shall be mounted in standard 19 inch mounting rails.
2. Drawer shall be made of steel and shall be black in color.
3. 4-RU Rack-mount drawer shall be Lowell #UDEL-414.

C. Where required, provide a balancing transformer for Ipod connections. Transformer shall be RDL #TX-10B or equal.

D. Custom Input and Output rack mount panel.
1. Contractor shall provide a panel that mounts in a standard 19” rack.
2. Panel shall hold all input and output connectors shown on the drawings and listed in the specifications.
3. Panel shall include custom screen printing to detail what the connectors are connected to.
4. Connect each connector to it’s associated input on the audio equipment.
5. Panel shall be made of steel and shall be black in color with white lettering.
6. See the drawings for the proposed layout of the panel. Provide a submittal showing the actual layout prior to ordering.

2.07 CLASSROOM AUDIO COMBO MIC AND AMPLIFIER SYSTEM

A. The system must have specifications including but not limited to the following:
1. Access (1.9GHz DECT Type) Technology wireless communication
2. Wireless transmission range: up to 200 ft. (600m) open field
3. Up to two microphones for whole room instruction, team-teaching or student sharing.
   a. Equip with one (1) microphone and neck lanyard.
4. Pendant-style classroom microphone with audio input utilizing Access Technology (1.9 GHz) for transmission.
5. Three (3) stereo audio inputs with master volume control
6. One line level audio output with level control
7. Two speaker outputs to power a total of 1-4 speakers

B. Amplifier/mixer
1. Wireless communication: Access (DECT Type) Technology
2. Wireless transmission range: up to 200 ft (60m) open field
3. Power output: 40 Watts Total (20 W / Channel)
4. Frequency response: 20 Hz to 20 kHz amplifier
5. Automatic power on when Microphone is powered on and linked
6. Controls:
   a. (1) Power button
   b. (1) Microphone volume control
   c. (1) Audio input volume controls
   d. (1) Audio output level control
   e. Tone control

C. Pendant-Style Microphone and transmitter
1. The pendant-style microphone/transmitter shall contain microphone volume control on the unit allowing users to adjust volume level from anywhere in the classroom.
2. Shall be capable of being worn around a teacher’s neck as a hands-free microphone via the lavaliere cord (provided by contractor) or to be used as a handheld student pass-around microphone.
3. Must be rechargeable via wall charger, computer, or Charging Station
4. Lanyard: adjustable length with magnetic clasp
5. Wireless communication: Access (Dect) Technology
6. Transmission range: up to 200 ft (60m)

7. Integrated microphone type: uni-directional electret
8. Audio input: 3.5mm
9. Earbud output: 3.5mm
10. Volume control: +/- 6dB (total range = 12 dB)
11. Power: on/off/mute button
12. Battery run time: 8 hours (fully charged)

D. Audio System Shall be Lightspeed #Cascadia T25 or equal.
1. Equip with one Lightspeed Clearmike or equal
2. Equip with Clearmike Charging cradle and adjustable lanyard

PART 3 - EXECUTION

3.01 EXAMINATION

A. Location of the communications infrastructure shall be finalized in the communications room prior to installation.

B. Locate all equipment to be installed, and make certain that space is available for maintenance and service during the life of the system.

C. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the communications layout to the Engineer for approval prior to installation.

3.02 AUDIO ELECTRONICS INSTALLATION

A. Contractor shall review design and building prior to ordering all components.

B. The Contractor shall be responsible for providing a complete system including all parts required for connectivity of all components.

C. All cables, connectors, supports, boxes, etc., shall be the responsibility of the Contractor.

D. The Contractor shall refer to the drawings for the installation notes and locations in the racks of all the equipment. If changes are required in the field, the Contractor shall submit the proposed changes in the form of updated rack/cabinet layouts. The Engineer shall have the final say on proposed changes.

E. All components required for a well-functioning system shall be provided and installed.

F. Interconnections between speakers and amplifiers shall be via terminal strips. Speakers shall not be directly connected to an amplifier. Terminal strips shall be mounted to the side of a cabinet, or to a piece of wood mounted to the back of the rack.
1. Provide self-adhesive labels for each of the speaker wires that come back to the terminal strip. Attach stickers to the area beside the terminal that the wire is connected to.
2. All wires terminated to the terminal strip shall have spade lugs attached. Size the spade lugs for the size wire and size of screw on the terminal strip.

G. When connecting speakers to the amplifiers, ensure the correct polarity throughout the system.

H. Contractor shall label all the volume, gain, etc., controls on all mixers and processors. The labels shall be self-adhesive labels. All labels shall specify the device that dial controls. All labels shall be laser-printed; handwritten labels are not allowed.

I. After connection of the system, the Contractor shall configure all components to ensure the best sound possible.
1. Contractor shall ensure that the correct speakers are connected to the correct output of the amplifier. This includes the surround sound processor (if applicable) and amplifier. contractor shall ensure that connections are made to each speaker.
2. Audio output shall be routed through the digital signal processor (if applicable) to limit the feedback noise to the speakers. Contractor shall consult with the manufacturer and ensure that the eliminator has been configured correctly.
3. Where a graphic equalizer is installed, the Contractor shall balance all the signals to provide the best sound possible. Utilize an acoustical tester.
4. All inputs such as CD players shall be integrated into the system. Utilize mixers and automatic mixers to combine microphones and other inputs.

5. Contractor shall test each and every input and output of the system. Contractor shall have the Engineer and Owner present for final testing and system checkout.

J. After installation, the Contractor shall provide as-builts and all component documentation.

K. Assisted listening systems shall be installed to support audio enhancement for people during use of the audio system in the specific room.
   1. Assisted listening systems shall be installed to support the personal audio devices that are handed out to the users
   2. Test the devices in the room so that they are shown to pick up the audio signal throughout the room
   3. Provide the devices to the owner with new batteries and a set of spare batteries.
   4. Connect the system to the main audio output in the cabinet.

3.03 MICROPHONE INSTALLATION.

A. All wired microphones shall be provided with a microphone cord. The cord shall have a female XLR connector for connection to the microphone, and a male connector for connection to the wallplate.
   1. Each cable shall be a minimum of 15 feet long. For gymnasiums and other locations where a longer cable may be required, provide a cable no shorter than 25 feet.
   2. At each wallplate/floorbox connection to an XLR, provide an engraved lamacoid label detailing the number of the microphone cable attached to the back of the wallplate. Stick the label to the wallplate just above the XLR connector.
   3. Contractor shall install wireless microphones where shown on the drawings.
   4. Wireless receiving units shall be rack mounted.
   5. Where the receiving unit is not in the room where the transmitter is located, the Contractor shall install antenna extensions for each receiver.
   6. The antenna shall be mounted in the room where the transmitter is to be located. Install the extension cables and antenna as per the manufacturer's recommendations.
   7. Where more than 1 receiver is in the same rack/cabinet, the Contractor shall install an active antenna consolidator that has the capability to combine up to 4 receivers. This consolidator shall then have antenna extensions located in the room the users will be transmitting from.
   8. Contractor shall be responsible for all cables and connectors needed to connect antennas.
   9. Provide either a handheld wireless microphone or belt pack and lavalier/headworn mic with each wireless receiver. Refer to the drawings for the type of microphone to provide.
      a. Contractor shall match the transmitter frequency to the receiver frequency.
      b. Where multiple receivers are required, ensure that the frequencies are all different, and that there will be no interference from the local radio signals from TV stations.
      c. Label each receiver and transmitter for the frequency chosen.
   10. Contractor shall provide wind screens for all microphones provided.
   11. After installation, the Contractor shall demonstrate that each wireless microphone works at any point in the room that it serves. The Contractor shall further demonstrate that the microphones all can work at the same time without interference.
   12. All microphones shall have new batteries provided at the time of installation.

3.04 AUDIO SYSTEM

A. The entire audio systems shall be configured to be a complete working system.

B. The Contractor shall label each speaker cable at each end with a wraparound label that has been laser printed.
   1. The Contractor shall give each speaker wire a separate designator. The Engineer shall approve the proposed numbering prior to printing the labels.

C. Each component shall be labeled for what it does and what it provides. Labels shall be laser printed, and shall be attached to the front of each unit.

1. For example, the amplifier in a cabinet may be marked “Microphone Amplifier-First Floor Hallway.”

D. It is extremely important that each microphone cable be labeled at each end with a laser printed wrap around label. This will allow the Owner to know exactly which microphone is being connected.
   1. Where microphones are terminated, the Contractor shall provide a minimum of 3 feet of spare cable for future movements.
   2. The Contractor shall provide the proposed labeling of the microphone cables prior to the actual installation of the labels.

3.05 TESTING (PRE-COMMISSIONING)

A. All systems shall be initially adjusted and set by the contractor, unless otherwise specified, in writing, by the Consultant or the architect.

B. A complete mechanical, electronic, and acoustical inspection to verify proper installation and operation shall be made, including mountings, interconnection, freedom from hums, buzzes, noise, and oscillation. Test procedures and documentation of results shall be provided with the system documentation.

C. All microphone and line level signal cables shall be verified for proper “Pin to pin” wiring. Example: Microphone cables; Pin 1 shall be Shield, Pin 2 shall be Positive (high or +), Pin 3 shall be Negative (low or -). Correct any irregularities and include documentation of results that shall be provided with the system documentation.

D. Polarity testing and verification shall be performed by the sound system contractor to verify; “Positive pressure on ALL microphones shall produce positive pressure at ALL loudspeakers.” It is the sound system contractor’s responsibility to correct all discrepancies found. Test procedures and documentation of results shall be provided with the system documentation.

E. Acoustical testing shall be in two phases. In the first, the intent is to obtain and document uniform coverage within the Auditorium seating areas. The intent of the second is to obtain an acceptable room response curve, naturalness of sound, and minimize feedback in all systems.
   1. Reproduce 1/3rd octave bandwidth pink noise, that is 10 dB above the ambient level of the gymnasium. Measure the sound levels at a minimum of 12 positions, along the front to back centerline, and along the front to back side aisles of the seating area. Determine that the sound level through the entire seating area is: plus or minus (+/-) 3 dB at 2 KHz. Adjust loudspeakers if necessary, either physically or electrically, to achieve these desired results. Document your results in writing to the Consultant.
   2. Reproduce a broadband 20-20KHz pink noise signal that is at least 10 dB above the ambient. Set a measurement microphone at the approximate center of the seating area. While no specific room response curve is specified, it is the intent to obtain a smooth response between 125 and 4000 KHz (+/-2 dB), with roll off at 3 dB per octave for two octaves above 8000 KHz, with more roll off beyond this frequency. After initial adjustment, reproduce both speech and music on the system and check for the naturalness of both, readjusting the EQ as necessary. Document filter settings and provide to the Consultant.
   3. Place the Podium or Handheld (wireless) microphones in their normal positions. Increase the level of each device, one at a time until each microphone is loud enough to be heard in any seat in the room. Document your finding and provide to the Consultant.

3.06 COMMISSIONING

A. The Audio Contractor will provide a technician to assist the Consultant during the commissioning of the system. The technician will be ready and available to make any necessary adjustments or repairs to the system that the Consultant finds in error of the specification.

B. The Audio Contractor will have on hand all installation documentation and equipment manuals. The Audio Contractor will have the necessary tools available for any adjustment or repairs.

C. Once the system is commissioned, the Audio Contractor will provide final As-built documents to the Consultant for review. These documents will reflect the true condition of the system after commissioning.

END OF SECTION 28 5450

SECTION 28 5453 – AUDIO SPEAKERS

PART 1 - GENERAL

1.01 SECTION INCLUDES
- A. Parts and equipment required for audio speakers and speakers supports.

1.02 SYSTEM DESCRIPTION
- A. The speakers shall be installed and configured to provide maximum coverage in each room.
- B. Install to allow maintenance to all speakers.
- C. Each speaker in an open ceiling shall be equipped with an aircraft cable safety cable.

1.03 COORDINATION
- A. Coordinate the location of all racks, cabinets, and audio equipment
- B. Coordinate with other Contractors who are doing work in the ceiling space. Coordinate the installation of all cables, speakers, etc., with the locations of other services.

PART 2 - PRODUCTS

2.01 IN-CEILING SPEAKERS -HIGH END AUDIO
- A. There are numerous type of speakers, and there are numerous applications for each of those speakers. The Contractor shall refer to the drawings and identify which speakers shall be installed for the most complete and well-designed sound enhancement system.
- B. Medium speaker -Drop ceiling mount.
  1. Speaker shall have a 6.5-inch low frequency transducer with a waveguide coupled 1” tweeter.
  2. Frequency response shall be 50 to 20,000 Hz at -10dB.
  3. Speaker shall have 70-volt transformer taps with 30 watts being the top end.
  4. Long term power handling shall be 80 watts with peak of 320 watts at 8 ohms
  5. Sensitivity shall be 90 dB SPL at 1 meter with 1 watt of pink noise.
  6. Speaker shall be fully enclosed with a screen-grill and shall be white in color.
  7. Each speaker shall be equipped with a mount and hardware that provides for its installation in the drop ceiling. Shall mount from the Grid
  8. Speaker shall be Electro-voice #C6.2-G2 or equal.
- C. Field house wedge (can be used for auditorium etc)
  1. Provide and install large speakers for the noted installation location.
  2. Shall be a Two-way, dual-6-inch point source loudspeakers with directivity control
  3. Shall incorporate
     a. Two 6-inch (170 mm) low frequency ceramic transducers mounted in a 90° V shape
     b. One, 1.75-inch (44.5 mm) voice coil
     c. One, 1-inch (25.4 mm) throat high-frequency neodymium compression driver mounted to a configurable rotatable horn.
     d. The horn shall be constituted of two half horns. The different half horn assemblies shall offer the following coverage options:
        A) Symmetrical: 120° x 50°, 90° x 50°
        B) Asymmetrical: 105° (60° + 45°)
        C) Contractor shall measure area to be covered with audio and provide the correct horn assembly
  4. The loudspeaker system shall be capable of operation in either passive mode or bi-amped with a crossover frequency of 1.5 kHz in bi-amp and 1.6kHz in passive mode.
  5. The loudspeaker system shall meet the following performance criteria:
     a. Frequency response of 70 Hz to 20 kHz, measured on-axis;
     b. Sensitivity (1W @ 1m) of minimum 101 dB SPL in free field;

c. Maximum rated SPL at 1m (passive) of 117 dB continuous and 129 dB peak (crest factor of 12 dB);
d. Rated power capacity (passive) of continuous 240W based on a two-hour power test; nominal impedance of 8 Ohms.

6. The loudspeaker system input connectors shall include both two NL4 Speakon connectors and one euroblock connector.
7. The loudspeaker enclosure shall be asymmetrical offering a 15° angle between sides and constructed of 12 mm Baltic birch exterior plywood and finished in black polyurea paint (RAL 9011).
8. The transducers and horn frame shall be part of an ABS front baffle.
9. The front of the loudspeaker shall be protected by an 18-Gauge (1.2 mm) powder-coated steel grille that is lined with acoustically transparent backing and a stainless metallic screen to prevent water ingress and is free of logos or other embellishment.
   a. This grille shall be treated against UV and corrosion.
10. The loudspeaker shall be IP54, and all exterior fasteners shall be stainless steel. The input cup shall be protected by a sealing plate.
11. The enclosure shall have two M8 inserts located on center of gravity on the top and bottom for an optional yoke bracket as well as three 4-hole pattern (4 x 2.25 pitch, M6) located on top, bottom and rear.
    a. Provide and install the Yoke bracket and any other bracket or supports required for proper mounting
12. The two-way full-range loudspeaker system shall be the Q-SYS #PL-DC26 loudspeaker.

D. Field House Speaker
1. Provide and install large speakers for the noted installation location.
2. Shall be a Two-way, full-range 15-inch coaxial loudspeaker
3. The professional high-power installation loudspeaker system shall be a two-way full-range design incorporating a 15-inch low-frequency neodymium transducer with a 3-inch (72.6 mm) voice coil and a 3-inch (76.2 mm) throat high-frequency neodymium compression driver mounted coaxially with the LF transducer.
4. The coverage shall be 80° conical and respect Direct Match Transition (DMT) technology.
5. The loudspeaker system shall be capable of operation in either passive mode or bi-amped with a crossover frequency of 1 kHz in bi-amp and 1700Hz in passive mode.
6. The loudspeaker system shall meet the following performance criteria:
   a. Frequency response of 37 Hz to 20 kHz, measured on-axis;
   b. Sensitivity (1W @ 1m) of minimum 100.5 dB SPL in free field;
   c. Maximum rated SPL at 1m (passive) of 117.5 dB continuous and 129.5 dB peak (crest factor of 12 dB);
   d. Rated power capacity (passive) of continuous 340W based on a two-hour power test; nominal impedance of 8 Ohms.
7. The loudspeaker system input connectors shall include both two NL4 Speakon connectors and one Euroblock connector.
8. The loudspeaker shall be IP54 rated for indoor and outdoor installations. All exterior fasteners shall be stainless steel. The input cup shall be protected by a sealing plate.
9. Mounting
   a. The enclosure shall have twelve M10 threaded-insert mounting points (two on each side, three on the top and bottom) for suspension via eye bolts,
   b. Shall include two M8 inserts located on center of gravity on the top and bottom for an optional yoke bracket as well as three 4-hole pattern (4 x 2.25 pitch, M6) located on top, bottom and rear.
10. The two-way full-range loudspeaker system shall be the Q-SYS PL-CA15 loudspeaker.
11. Provide custom installation to fly speaker and mount to structure.

a. Contractor shall be responsible for custom install and aiming speaker to cover the area and minimize “stray” audio.

E. Field House Subwoofer
1. Provide and install Passive 18-inch installation subwoofer for the noted installation location.
2. The subwoofer shall be a bass reflex design incorporating an 18-inch low frequency ceramic transducer with a 4-inch voice coil.
3. The subwoofer shall meet the following performance criteria:
a. Frequency response of 38 Hz to 101 kHz, measured on-axis; sensitivity (1W @ 1m) of minimum 97 dB SPL in half space;
b. Maximum rated SPL at 1m (passive) of 126 dB continuous and 138 dB peak (crest factor of 12 dB);
c. Rated power capacity (passive) of continuous 750W based on a two-hour power test; nominal impedance of 8 Ohms.
4. The subwoofer input connectors shall include both two NL4 Speakon connectors and one euroblock connector.
5. The subwoofer shall be IP54 rated, and all exterior fasteners shall be stainless steel. The input cup shall be protected by a sealing plate.
6. The subwoofer shall have a 6-point integrated rigging system allowing the deployment of 6 subwoofers with a safety factor of 10:1.
7. Provide custom installation to fly speaker and mount to structure.
a. Contractor shall be responsible for custom install and aiming speaker to cover the area and minimize “stray” audio.
8. The loudspeaker shall have a net weight of no more than 102.2 lb (46.3 kg).
9. The Passive 18-inch installation subwoofer shall be the Q-SYS #PL-SUB18 loudspeaker.
10. Provide custom installation to fly speaker and mount to structure.
a. Contractor shall be responsible for custom install and aiming speaker to cover the area and minimize “stray” audio.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Location of the communications infrastructure shall be finalized in the communications room prior to installation.
B. Locate all speakers and ceiling types where speakers are to be installed, Review prior to ordering and provide correct speakers and speaker mounting hardware
C. Where speakers are mounted from the ceiling or other structure the contractor shall provide all mounting hardware and misc. hardware.
D. If any changes from the drawings are required, the Contractor shall submit a proposed layout of the speakers to the designer for approval prior to installation.

3.02 IN-CEILING SPEAKERS
A. In-Ceiling speakers shall be mounted flush with the ceiling.
B. The Contractor shall provide all equipment required to flush mount the speaker into the drop ceiling or plaster ceiling. Refer to reflected ceiling plan for ceiling type.
C. Contractor shall work with the Engineer and ceiling installer to locate all speakers where other equipment will not impede the installation.
D. Where the manufacturer provides a T-bar support for the speaker, the Contractor shall provide and install the support in drop ceiling installations.
E. Speaker wire shall not lay on the ceiling. All speaker wire shall route through conduit, tray or J-hooks.
F. The Contractor shall leave a coil of speaker wire in the ceiling to allow lowering of the speaker for maintenance and removal.

G. The Contractor shall work with the manufacturer to determine the best layout of the speakers, and shall submit that layout for review prior to installation. The Engineer shall approve the installation prior to installation.
H. After installation, the entire system shall be tested, and it shall be demonstrated that each speaker is connected and in good working order.
I. It shall be further demonstrated that all audio can be easily heard throughout each room where speakers have been installed.
J. Contractor shall provide all speaker wire and connectors required to connect the system.
K. Ensure that all speakers have been connected to the correct amplifier.
L. For speakers in the commons area, the contractor shall install a safety strap that consists of an aircraft cable attached to the structure and the speaker housing.

3.03 WALL OR OPEN CEILING SPEAKERS

A. Speakers hung from the ceiling shall be positioned to provide full coverage of the area.
B. The Contractor shall suspend speaker from the ceiling where shown on the drawings. The Contractor shall be responsible for installing the speakers at the correct angle to fully cover the area.
    1. Complete all calculations to aim all speakers and fully cover the area evenly with audio.
    2. Provide all hardware from manufacturer and misc. hardware required to mount the speakers from the building structure.
C. Contractor shall provide all the equipment required for mounting each speaker. Use manufacturer's recommended supports when possible.
D. Align speaker so that they provide full coverage of the area.
E. The Contractor shall leave a coil of speaker wire in the ceiling to allow lowering of the speaker for maintenance and removal.
F. The Contractor shall work with the manufacturer to determine the best layout of the speakers, and shall submit that layout for review prior to installation. The Engineer shall approve the layout prior to installation.
G. After installation, the entire system shall be tested, and it shall be demonstrated that each speaker is in connected and in good working order.
H. It shall be further demonstrated that all audio can be easily heard throughout each room where speakers have been installed.
I. Contractor shall provide all speaker wire and connectors required to connect the system.
J. Ensure that all speakers have been connected to the correct amplifier.
K. Where speakers are exterior installed the cabling shall be weatherproof and all connectors shall be weatherproof
L. Install aircraft safety cable to attach each speaker directly to building structure. Shall be in addition to any other custom mounting hardware.

END OF SECTION 28 5453

SECTION 28 5470 – AV CABLING

PART 1 - GENERAL

1.01 SECTION INCLUDES
- A. This section includes parts and equipment required for installation, termination, and testing of user communications cables.

1.02 SYSTEM DESCRIPTION
- A. Cabling and infrastructure shall be fully installed and connected and labeled.
- B. Products and installation detailed in this section shall comply with all applicable requirements.

1.03 COORDINATION
- A. All cables shall be coordinated with the installation of the telecommunications raceways.
- B. Coordinate all cables with the furniture to be installed in the building. Make any adjustments prior to cable being installed.

PART 2 - PRODUCTS

2.01 UNSHIELDED/TWISTED PAIR CABLING CAT-6
- A. CAT-6 UTP cable for Ethernet and IP video Transmission
  1. Category 6 cabling shall consist of 4 pairs of unshielded twisted pair, 23 AWG cables.
  2. All CAT-6 cables shall be installed in cable tray or supported by J-Hooks.
  3. Individual pair shall be marked in the standard 4 pair color code of blue/blue-white, orange/orange-white, green/green-white, and brown/brown-white.
  4. Each cable shall be marked sequentially with the footage of the cable. Each cable shall also be marked with the manufacturer of the cable and the type of cable installed or the cable part number.
  5. CAT-6, 4 pair cabling shall be plenum rated unless specifically noted.
     a. Cat-6 UTP Cables for Audio/Video Connectivity shall be:
        1) White in color, Mohawk #M58580 or equal.
        2) Black in color, Mohawk #M58289 or equal.
        3) Orange in color, Mohawk #M58288 or equal.
  6. Ensure that cable passes all CAT-6 tests after installation.
- B. CAT-6 Unshielded Twisted Pair Termination equipment
  1. CAT-6, 8-pin modular jacks for UTP cable shall be:
     a. Data Jacks for Audio and Video connections shall be:
        1) Hubbell #HXJ6W-White
        2) Hubbell #HXJ6BK-Black
        3) Hubbell #HXJ6OR-Orange
  2. Where data cables route back to a rack or cabinet the contractor shall terminate all cables. Rack mount Patch panel shall be Hubbell
- C. Patch Panels
  1. Where data cables route back to a rack or cabinet the contractor shall terminate all cables onto modular jacks and those jacks shall be mounted into a patch panel.
     a. Rack mount Patch panel shall be:
        1) Hubbell #HPJ24
        2) Equip each panel with rear cable support bars.

2.02 SHIELDED TWISTED PAIR CABLING
- A. CAT-6A STP for Video Transmission
  1. Category 6A Shielded cabling shall consist of 4 pairs of shielded twisted pair, 23 AWG cables.
  2. All CAT-6A cables shall be installed in cable tray or supported by J-Hooks.
  3. Individual pair shall be marked in the standard 4 pair color code of blue/blue-white, orange/orange-white, green/green-white, and brown/brown-white.

4. Each cable shall be marked sequentially with the footage of the cable. Each cable shall also be marked with the manufacturer of the cable and the type of cable installed or the cable part number.
5. CAT-6A, 4 pair shielded cabling shall be plenum rated unless specifically noted.
    a. Cat-6A STP Cables for Audio/Video Connectivity shall be:
        1) White in color, Mohawk #M59242 or equal.
        2) Black in color, Mohawk #M59244 or equal.
        3) Orange in color, Mohawk #M59238 or equal.
6. Ensure that cable passes all AV Signals after termination.

B. CAT-6A Shielded Termination equipment
1. CAT-6A, 8-pin modular jacks for STP cable shall be:
    a. Data Jacks for Audio and Video connections shall be:
        1) Hubbell #HJS6AW-White
        2) Hubbell #HJS6ABK-Black
        3) Hubbell #HJS6AOR-Orange

C. Where data cables route back to a rack or cabinet the contractor shall terminate all cables onto modular jacks and those jacks shall be mounted into a patch panel.
1. Rack mount Patch panel for CAT-6A Shielded cables shall be:
    a. Hubbell #PSJ24BK
    b. Equip each panel with rear cable support bars.

2.03 FACEPLATES

A. Custom AV plates.
1. Some locations will require custom stainless-steel plates. These shall be configured with the correct connectors and pass thru's to support all the data, audio and video.
2. All shall be silk-screened to detail what each connector is for.
3. Submit a product sheet for approval prior to purchase of the plates.
4. UTP Jacks shall be flush with the front of the plate
5. Provide custom plates for various audio and video inputs.
6. Plates shall be aluminum or steel.
7. Shall be custom plates or style-line style with stainless steel plates.
8. See drawings for description
9. Shall be Covid Brand or equal

B. Stainless Steel coverplate with Style-Line (GFI) opening
1. Single-gang plates shall be Hubbell #SS26
2. Double-gang plates shall be Hubbell #SS262

C. Brush opening plate
1. Where routing AV cables through an open backbox the contractor shall install a "brush" plate that covers the backbox and allows cable to pass thru
2. Provide a single or double gang cover plate with GFI openings.
3. Single-gang plates shall be Hubbell #SS26 with Leviton #41078-DBW, White in color or equal
4. Double-gang plates shall be Hubbell #SS262 with Two (2), Leviton #41078-DBW, White in color or equal

D. Style-line (GFI Rectangular) and 106 style inserts.
1. In addition to flush faceplates and surface housings, some installations call for integrated furniture outlets, GFI style outlets, and standard 106 style frames. These may be required at some surface raceway location. Field verify prior to ordering.
2. The Contractors shall identify which type of outlet or frame is required at each location throughout the system.
3. Match the outlet with the faceplate required.
4. GFI, more commonly referred to as style line outlets, are rectangular and fit in a rectangular plate used for GFI receptacles.

5. Each type of modular furniture has certain requirements for its voice and data modules. The Contractor shall coordinate with the furniture installer and provide the correct faceplate and outlets to match the color and style of the furniture.
6. The 106 style frame fits in a common duplex electrical receptacle faceplate. The frame holds 2 or 4 modular jacks.
7. For all connections that do not have a faceplate with a location for a laser printed paper label, the Contractor shall provide an engraved lamacoid label detailing the location number of each cable.
8. GFI/Style-line Plates shall be:
    a. Hubbell
        1) Two port, Hubbell # NS612W
        2) Three port, Hubbell # NS613W,
        3) Four port, Hubbell # NS614W
        4) Six port, Hubbell # NS616W.
        5) Blank, Hubbell #NS620W
9. 106 style plates shall be
    a. Hubbell
        1) Two port, Hubbell # BR106W
        2) Four port, Hubbell # Q106OW

2.04 SURFACE MOUNT BOXES

A. Provide surface mount boxes for termination of cables as shown on the drawings.
    1. Install a surface mount box at location for termination of the modular jacks.
    2. Hubbell Part numbers.
        a. One port surface box shall be Hubbell #HSB1BK.
        b. Two port surface box shall be Hubbell #HSB2BK
        c. Four Port Surface box shall be Hubbell #HSB4BK

2.05 AUDIO CABLING

A. Audio Cables
    1. Cable to be used for connection of the Audio between devices.
    2. Cables in the ceiling shall be plenum rated.
        a. Where noted the audio shall be terminated onto the back of a connector at the faceplate.
        b. Coordinate cable terminations with the devices to which they will connect.
        c. Label each cable at each termination point for the device at the other end of the cable. Include port number.

B. Speaker Wire:
    1. The Contractor shall size the speaker wire for the distance between the amplifier and the speaker, as well as the impedance of the speaker.
    2. Speaker wire resistance shall not exceed 7 percent of the speakers' impedance.
    3. Speaker wire shall be no smaller than 18 AWG.
    4. Speaker wire shall be high conductivity, copper cable. Cable shall be of single pair, stranded construction. Cable shall be 2 parallel cables, black in color and 1 of the conductors shall be marked for identification at each end.
    5. Cable shall be a minimum of 99.95 percent copper.
    6. Provide plenum rated wire when the cable will route through a plenum area. Contractor shall be responsible for identifying plenum areas.
    7. Speaker cables for these systems shall be homeruns from the speaker to the terminal strip. There shall be no splices in the cable.
        a. 18 AWG plenum Speaker cable shall be West Penn #25224B or equal
        b. 16 AWG plenum Speaker cable shall be West Penn #25225B or equal
        c. 14 AWG plenum Speaker cable shall be West Penn #25226B or equal
        d. 12 AWG plenum Speaker cable shall be West Penn #25227B or equal
        e. 10 AWG plenum Speaker cable shall be West Penn #25210 or equal

C. Microphone bulk cable:
1. Microphone cable shall be for use with all types of microphones.
2. Each microphone cable to be terminated in the field shall have 4 conductors of which two are used for each terminal on an XLR connector.
3. Cable shall contain 4 stranded, 24 AWG conductors covered with a braided shield with a minimum of 75 percent coverage.
4. Microphone cable shall be yellow in color.
5. Microphone cable, Riser rated shall be Belden 1800B or equivalent.
6. Microphone cable, Plenum rated shall be Belden 1801B or equivalent.
7. All microphone cable shall be terminated with 3-pin XLR connectors. Connectors shall be Neutrik #NC3MX or equivalent.

D. Line Level Audio
1. To connect audio equipment at line level the contractor shall provide cables for connection.
2. Where bulk cable is used for phoenix style connectors the contractor shall provide single-pair stranded audio cable.
3. Microphone cable shall be 24 AWG (7x32) tinned copper
a. Overall Shield with 100% coverage
b. Plenum rated cable shall be Belden #1801B
c. Non-Plenum shall be Belden 1800B
d. Underground Audio line-level cable shall be Belden #5500F1

2.06 VIDEO CABLING

A. All cabling that is in a plenum rated area shall be plenum rated.

B. HDMI cables
1. Where cables route through a drop ceiling the cables shall be plenum rated.
2. Cables shall be of sufficient size to carry the signal over the distance required.
3. Cables to connect device to device shall be HDMI male to male.
4. At the locations where the cables route into devices at the desk or shelf the contractor shall provide short, flexible male to female cables.
5. Standard HDMI cables shall be no longer than 35’.

C. Active HDMI cables.
1. Approved manufacturers:
a. FSR
b. Legrand
c. Panduit
d. Hall Research
e. Cables 2 Go
2. Where the HDMI cable will be longer than 35’ the contractor shall provide Active HDMI cables or UTP/STP cabling and HDMI to CAT-6 transmitter/receiver.
3. Video Resolution shall meet or exceed:
a. HDMI resolutions up to 3840x2160 @ 30 (4K UHD),
4. HDMI Compliance: EDID, CEC HDCP2.2, HDMI 2.0
5. Audio Standards Supports PCM, Dolby, True HD, DTS-HD
6. Powered from HDMI output device or Thru USB connectivity at the display. (Ensure there is USB power at the display or provide a power brick)
7. All Active HDMI cables shall pass signal from Chromebooks/Laptops. Prior to ordering the Active HDMI cables the contractor shall test one cable with the owners Chromebooks.
a. If the contractor fails to test prior to ordering then they shall replace all active HDMI cables that do not pass the owners Chromebook/Laptop HDMI signals
8. Active Copper HDMI cables, Plenum shall be:
a. Legrand-Cables 2 Go or equal
1) 25’ Active copper HDMI Cable Plenum, Cables 2 Go # 42529

2) 40’ Active copper HDMI Cable Plenum, Cables 2 Go # 42531
3) 50’ Active copper HDMI Cable Plenum, Cables 2 Go # 42532

9. Active fiber HDMI cables, Plenum shall be:
   a. FSR or equal: (No outside power required)
      1) 10 Meter Active Optical HDMI Cable Plenum, FSR #18384
      2) 15 Meter Active Optical HDMI Cable Plenum, FSR #18385
      3) 23 Meter Active Optical HDMI Cable Plenum, FSR #18386
      4) 30 Meter Active Optical HDMI Cable Plenum, FSR #18387
      5) 46 Meter Active Optical HDMI Cable Plenum, Hall Research Javelin, #CHD-AP46
      6) 60 Meter Active Optical HDMI Cable Plenum, Hall Research Javelin, #CHD-AP60
10. Active fiber HDMI cables, Mini-connector active HDMI cables for Small conduits.
   a. These are combo fiber/copper cables that transmit HDMI signals
   b. There are small connectors that can be used to pull thru conduits. Then apply the proprietary to HDMI caps after installation to connect devices.
   c. Cables shall be ordered with correct length and shall be plenum rated
   d. Cables shall be Hall Research #CHD-DExx where xx is the length.

2.07 USB CABLING

A. USB faceplates
   1. Where noted on the drawings, provide USB pass thru plates with pigtails.
B. USB cables
   1. For connection of devices provide USB-A male to USB-A male cables.
   2. For extension of USB cables, provide USB-A male to USB-A female cables
   3. Where required, provide USB cables that have USB-A male and USB-B male connectors
   4. For extension of USB signals more than 20’ the contractor shall provide Active USB cables and connectors that meet USB 3.0 requirements
      a. Active USB cables can be Type A/B connectors or Type C connectors with Adapters to fit and connect the devices at each end.
      b. Active USB cables shall be Hall Research 3.0 /3.1 Javelin type cables or equal
         1) Shall support legacy USB connectivity of 1.1 and 2.0

2.08 PATCH CABLES

A. Contractor shall provide all patch cables and gender changers required for a complete system.
B. Provide all flexible connections for video HDMI connections where required to connect to a device and the long-distance HDMI cable is not flexible enough.
C. All patch cables between devices that hard-wire between devices shall be labeled at each end detailing which device they connect to at the other end.
D. Provide tabletop and device side patch cables for connection of all devices at the conference room tables etc.
E. Patch cables shall be provided at each faceplate or tabletop device and all connections at the plate. Shall be no shorter than:
   1. 8’ for top of table connection to table mounted plates
   2. 15’ for connection from table to wall mounted plates.

2.09 CONTROL PANEL FOR BASIC VIDEO SYSTEMS

A. Basic presentation controller
   1. Where noted provide a button panel that includes a control system. Integrate this control panel to the AV system for control of items shown.
   2. The button panel shall meet the following:
      a. (6 or 8) Assignable pushbuttons with interchangeable pre-labeled button caps, support macros

b. Shall be supplied with buttons that are labeled with icons for Power On, Power Off, Power Toggle, Volume Up, Volume Down, Mute, DVD Player, Generic Source, Computer 1, and Computer 2, plus set of 3 unlabeled
c. Provide custom engraved buttons when noted on the drawings.
d. Communications and connectors
1) 1-Ethernet: On an RJ–45 female connector for device configuration, control and firmware upgrade
2) 2 -RS-232: On 3–pin terminal block connectors
3) 1 -RS-485: On a 3–pin terminal block connector
4) 1 -K-NET: On a 4–pin terminal block connector
5) 2 -Relays: On 2–pin terminal block connectors (30V DC, 1A max)
6) 1 -GPI/O: On a 2–pin terminal block connector
7) 1 -Mini USB: On a female mini USB–B connector for configuration and firmware upgrade
e. Power to the device
1) Source: 12V DC 2A power supply. Provide a power supply and wire from the back of the display.
3. Button panel shall be Kramer #RC-206 Controller or equal

2.10 CABLE INSTALLATION TOOLS

A. Cable covering Nylon Mesh
1. To connect the faceplate on the wall to the desk or cabinet or other device install a flexible, semi-rigid, split braid.
2. Install all AV and data cables thru through a nylon mesh cable cover.
3. Mesh cover shall be flexible and shall be tie wrapped to the cables at each end.
4. Nylon Mesh shall be Tech Flex #F6Nx.xx series or equal.
5. Shall be White at the projector, black as it transitions from wall to desk or lectern.

B. All cables shall be supported in the ceiling a minimum of every 5 feet. Support can be provided by installing cable inside cable tray or conduit, or by installing J-hooks every 5 feet.
1. J-hooks shall provide a smooth steel or plenum rated plastic, support for cables as they route through the ceiling.
2. Steel supports shall have a galvanized finish.
3. Steel, UL listed, ultimate static load limit 50 pounds rated to support Category 5e and higher cables, and optical fiber cables.
4. If required, assemble to manufacturer recommended specialty fasteners, including beam clips and flange clips.
5. Acceptable products shall be:
a. CADDY #CAT HP series with retainer hooks.
b. CADDY #CAT-CM SERIES
6. Provide with interfaces and clamps required to support J-Hooks from the building structure.
7. Provide threaded rod and associated hardware required to support all J-Hooks

C. Firestopping shall be completed inside and around all conduits after cable installation. Firestop for the area between the cable and the edge of the conduit shall be Nelson No. FSP, CLK or LBS+. Contractor shall install the best firestop for each individual installation.
1. Firestop shall be installed with regard to local and national building codes.
2. The firestop shall be a putty like substance that expands under heat and will not allow flame to pass for a designated period of time.
3. Firestop shall conform to all NEC, NFPA, and UL requirements.
4. Some wall pass-thru’s are shown on the drawings. The Contractor shall utilize these where possible.
5. Where the contractor must install cables through a wall where there is no pass-thru already provided, the Contractor shall be responsible for installing a fire-rated pass-thru and fire-stopping the conduit after cable installation.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine all pathways prior to installation of all cables.
   1. Identify locations of all user conduits and backboxes prior to cable installation.
   2. Walk thru the building during construction and identify all boxes
   3. Coordinate installation of height of all boxes with the raceway installer.

3.02 PREPARATION

A. Locate main path for all cables and install J-hooks where cable tray is not provided.
B. Coordinate with other trades to install a clear, straight path down major corridors for the routing of user cables back to the communications closet.
C. Meet with construction manager to understand timing of ceiling grid and drop ceiling tiles.
D. Meet with electrical contractor to understand power installation schedule.

3.03 AUDIO AND VIDEO CABLE INSTLLATION

A. All AV cabling shall be installed according to TIA/EIA 568 standards, including all updates and addenda.
   1. When installing AV cables, care shall be taken to avoid crimping or bending the cable past the manufacturer's recommended bend radius.
   2. During installation, the cables shall not be pulled across the ceiling tiles or the structure of the building. This may cause damage to the cable jacket.
   3. Adhere to all pulling tensions and bend radii during installation. Excessive pulling or bending can cause the cable to fail tests after installation. Any cable that does not pass the intended signal after installation shall be fixed or replaced at the Contractor's expense.
   4. All cables shall route neatly in the ceiling. Whether they route in cable tray or J-hooks, the cables shall be neat and orderly.
   5. Install J-hooks and other cable supports to support all cables for the AV systems.
      a. In Gyms and cafeteria's, the contractor shall hide the speaker cable in the building steel whenever possible.
   6. Support all cables at a minimum of every 5 feet.
   7. Provide a short coil of extra cable where the cable enters the vertical conduit. The coil shall consist of no less than 1-1/2 feet.
   8. Provide enough slack in the backbox, to fully remove the faceplate and jack and allow work to be done on the cable.
   9. When installing cables in the communications room and AV cabinets, all cable shall route neatly through the cable tray and cable ladder and along the side of the cabinets.
      a. Install cable routing panels in the cabinets and racks where required.
   10. When transitioning from the ceiling area to the rack or cabinet, all cable shall route through conduits or be attached to vertical section of cable ladder.
      a. The Contractor shall provide the conduits shown and any additional conduits or cable ladder required to neatly transition cables from the ceiling to the rack.
   11. Cables shall route down each side of a rack for termination. Split each panel into 2 sides.
   12. All speaker cables shall be terminated on a terminal strip.
      a. Attach this terminal strip to the wall or to a panel in the rack/cabinet
      b. Identify each speaker cables at the terminal strip and on each side of the strip
      c. Install patch cables from terminal strip to the amplifiers. Label the speaker cable at the amplifier
   13. When terminating cables, ensure that the smallest amount of jacket is removed from the final termination point of the cables.
   14. Provide a service loop of the cables on the wall or to side of cabinet. The loop shall extend no less than 1 foot below the termination point on the patch panel. Route the

cables 1 foot below the device, and then back up to the device. This will provide room for future moves and additions to the rack.

15. Each cable shall have a self-adhesive, self-laminating, laser printed label at each end. The label shall show the device the cable attached to.
    a. Labels shall be installed no more than 4 inches from the termination point of the cable.

3.04 FACEPLATE/CUSTOM PLATE INSTALLATION

A. Faceplates/custom plates shall be mounted straight and level with the floor and walls of the building.
   1. Jacks and/or connectors shall be terminated to the appropriate cable and inserted in the correct orientation into the faceplate prior to the mounting of the faceplate.
   2. Each connector shall have a laser-printed or engraved/painted label detailing what it connects to.
   3. Cable slack shall be stored behind the faceplate in such a way that allows the minimum bend radius of the cables to be maintained as per the following:
   4. Care shall be taken when mounting the faceplate to avoid crimping or kinking the cables.
   5. Equip with all connectors and pass thru's shown on the drawings.
   6. Provide a cutsheet on the custom plates as part of the submittal process. Get designer approval prior to ordering and labeling.

B. Custom panels in racks
   1. Where noted the contractor shall provide a custom panel in the rack or cabinet to support the cables and inputs shown.
   2. Equip the panels with the control faceplates and/or input and output connectors.
   3. Label each input and output and control plate with a phenolic label for detailing the device that this connects to. Shall include port number or input number on devices.
   4. Provide a cutsheet on the custom panels as part of the submittal process. Get designer approval prior to ordering and labeling.

3.05 PATCH CABLE INSTALLATION.

A. The contractor shall provide and install all patch cables and gender changes and baluns as required for complete system connectivity.

B. Install patch cables from the table or floorbox to the tabletop for connection of the systems.

C. Provide and install any DVI or Display port to HDMI devices for transmission of the AV signals
   1. Connect each device to the plate or other device with patch cables and interconnection cables.
   2. Keep all patch cables short where possible unless otherwise noted on the drawings. Large coils of extra patch cables are not required.
   3. Where there are two of the same type of cables routing to one device, provide different color cables or provide different color tape at each end of each cable.

3.06 CONTROL PANEL.

A. The control panel shall be installed as shown on the drawings. Provide all the appropriate push buttons in the plate.

B. Meet with the owner to determine the sequence of how the control panel should work and what it shall control.

C. Install all cabling and sensors/devices required to transmit the signal and control the devices that are to be connected.

3.07 CABLE MESH

A. Nylon Mesh.
   1. At each lectern location, the contractor shall install the patch cables between the wall faceplate and the lectern inside a mesh cable sleeve.
   2. At the projector install the cables from the backbox or drop ceiling through the mesh. Match color of wall when possible.

a. The contractor shall route all cables through the nylon mesh. This includes all data and AV cables.
b. Install the power cable inside the mesh.
c. Tie wrap the nylon mesh at each end.

END OF SECTION 28 5470

SECTION 28 7200 – TECHNOLOGY SUBMITTALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section provides the Contractor with requirements regarding Product Data Sheets, Shop Drawings and Product Samples collectively referred to as “Submittals”.

B. This section provides the Contractor requirements regarding As-Built Documentation after installation and prior to Final Completion and Final Payment

C. The requirements of this section deal only with those submittals that are required to be provided by the chosen contractor after bid award. No submittals in this section are required to be provided with the Bid Response.

D. The requirements contained herein should be considered bound and apply to all technology and security specification sections per this contract.

1.02 PRE-INSTALLATION SUBMITTALS

A. The contractor shall provide material submittals to the Construction Manager or directly to the designer, whichever is managing the project.

B. Prior to beginning work, the chosen Contractor shall provide PDF files of all material submittals.

1. Highlight the part number of each item specifically. Submittals that are not highlighted will be rejected and sent back immediately.
2. Match camera submittals with the camera type on the drawings. see Security Equipment Schedule on TC501. Provide marking on the PDF File detailing which camera type is being submitted.
3. Provide the PDF with the following file names
   a. Site - Spec Section - Description
   b. In Example: K**ent City 28 1600: Data Cabling submittal**

1.03 AS-BUILT DOCUMENTATION

A. The contractor shall provide As-Built documentation to the Construction Manager or directly to the designer, whichever is managing the project.

B. Provide the As-Builts in hard and soft copy

1. Hard Copy shall include all Red-lined Drawings showing what was actually installed and where it was installed.
2. Soft copy on USB Drives (PDF or Microsoft Word or Excel) shall include all documents provided in the hard copy plus any configuration or data files. Include XLS files for all spreadsheets.

PART 2 - PRE-INSTALLATION SUBMITTALS

2.01 PRODUCT DATA SHEETS

A. Product data sheets shall consist of the manufacturers detailed specification sheets or “cut-sheets” for each product that is to be installed by the contractor or any subcontractors.

B. Product data sheets shall minimally include, but shall not be limited to:

1. Part Number
2. Manufacturer
3. Description of the product
4. Physical dimensions and characteristics of the product
5. Picture or manufacturers drawing of the item, where applicable
6. Electrical characteristics of the product including heat-load for active electronics.
7. Optical characteristics of the product for Fiber-Optic equipment and cable.

C. Provide product data sheets for all equipment and cabling that is to be installed by the contractor

D. Provide a PDF of all the Equipment being submitted. Each actual part number shall be highlighted on the PDF in yellow.
   1. Group Product Data Sheets by:
      a. Data Cabling
      b. Fiber Optic cabling
      c. Access Control
      d. Video Security
      e. Audio and Video Systems

2.02 SHOP DRAWINGS

A. Shop Drawings shall consist of detailed drawings showing actual connectivity, equipment to be installed and cable types for the systems noted below:
   1. Specialty AV system one-line connectivity
   2. Access Control system connectivity
B. Shop drawings shall also be provided for systems that the contractor intends to connect differently than what is shown on the contract drawings or where no connectivity is shown.

2.03 PRODUCT SAMPLES

A. Product Samples shall consist of a sample of the actual product that is to be installed.
B. Samples shall be tagged with the part number and specification section to which it pertains.
C. Product Samples shall be provided for the following:
   1. None at this time.

2.04 SUBMITTAL DOCUMENTS

A. The Contractor shall provide all Submittals to the Construction Manager or the designer
B. The Contractor shall provide PDF Files for all Product Data Sheets.
   1. All Product Data sheets shall be PDF files grouped as shown in 2.01/D
   2. The Contractor shall highlight the actual part number on the sheet of the component that they are submitting.
   3. If no part number is highlighted or marked with an arrow, then the entire submittal package will be rejected and sent back for re-submission.
C. The Contractor shall provide 1 set of PDF of Shop Drawings.
   1. Shop drawings shall be marked for the specification section of the bid documents to which they pertain. Mark the Detail (TCXXX/Y) to which the Shop Drawing refers.
   2. All shop drawings that are required to be drawn on the building background shall be provided on full-size drawings the same scale as those in the bid documents.
   3. All lines on the shop drawings shall be highlighted or completed in ink that is not the same color as that provided in the bid documents.
   4. The contractor shall provide a drawing legend detailing all symbols used in creation of the shop drawings.
D. The Contractor shall provide one of each product sample required to be submitted.
   1. Provide a cutsheet with each product sample detailing the specifics of the product and what it is proposed to be used for.

2.05 SUBMITTAL REQUIREMENTS

A. Submittals shall be provided for approval prior to installation of the work.
B. Any equipment installed that does not have an approved submittal associated with it can and will be removed from the project and replaced with other equipment as defined by the Designer. All replacement costs shall be the responsibility of the Contractor.
C. It shall be the responsibility of the Contractor to provide the submittals for review in sufficient time to not delay the installation. Work with the Construction manager on the schedule.
D. It shall be the responsibility of the contractor to ensure they have provided and have on hand “Reviewed” or “Furnish as Corrected” submittals for all equipment they install.
E. When reviewing submittals marked “Furnish as Corrected” take into account the comments and incorporate the comments into the products and installation of the systems.

PART 3 - AS-BUILT DOCUMENTATION

3.01 MATERIALS

A. The Contractor shall provide the following to the Designer prior to the issuance of the final payment.
   1. Approved submittals and equipment user manuals.
   2. As-Built Documentation as detailed below.
   3. All spare parts and cover plates for all components of the systems
   4. Manufacturer warranty cards for all components.

3.02 AS-BUILT PROCESS

A. The Contractor shall provide all project as-builts to the designer at substantial completion.
   1. Provide them to the designer for review
   2. Make any required changes the designer requests
   3. Re-submit at the time of Final Completion / final payment. Final Payment is not possible without a complete post installation deliverable package

3.03 PREPARATION

A. All documents for As-Builts and test results shall be neat and clearly labeled with listing of the project and documents included in each binder.
B. Quantity:
   1. Submit Red Lined, As-Built floorplans for the Systems detailed in 3.04/D.
      a. Provide one set of physical documents, full size,
      b. Provide PDF Scans of the As Built Floorplans.
   2. Submit Electronic files for As-Built Documentation
      a. Provide PDF Files. Provide a Coversheet that details:
         A) Client name.
         B) Project name.
         C) Manual title (e.g., “Project Close-out Manual for security system upgrade”).
         D) Date; date format: <month> <day>, <year> (e.g., “January 1, 20xx”).
         E) Installer and General Contractor names and contact information
         F) Warranty contacts for all systems.
      b. Submit Electronic files to Owner, Designer and Construction Manager via email or dropbox or directly through USB Drives.
   3. Submit (2) USB Drives with all As-Built documentation and software configurations.
      a. Software configurations shall be provided for:
         A) Video security NVR and camera/user database
         B) Access control system configuration and database

3.04 PROJECT DELIVERABLES

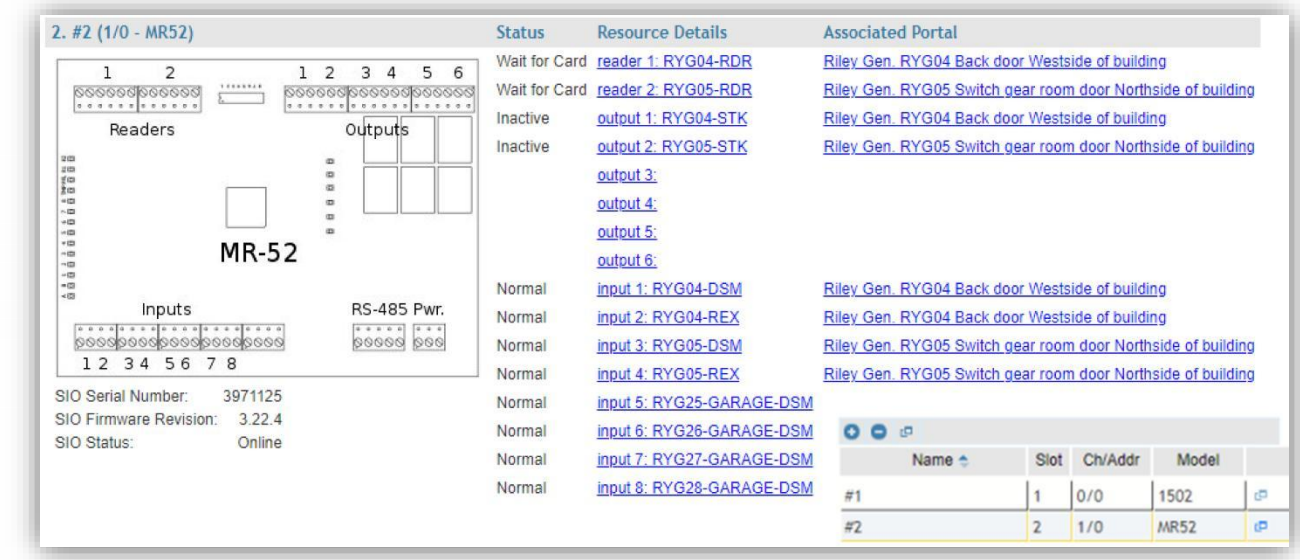
A. Provide a copy of all submittals and manuals and pamphlets.
B. Provide a copy of all Warranty documents and contact numbers for Warranty requests.
C. The contractor shall provide one set of full sized as-built prints. Provide a PDF of the as-built prints on the USB drives or via Email or Dropbox.
   1. Provide a clean set of the latest drawings with red lines marked for all field changes or bulletins. See above for systems to be included on the As-Built prints
D. The As-Built drawings shall include:
   1. Changes to be reflected on the drawings for Video Security Systems shall include:
      a. Camera locations
      b. Cabling Paths
      c. Camera numbers
      d. Comm room where camera connects to.

2. Changes to be reflected on the drawings for Access Control/Alarm Systems shall include:
    a. Changes to hardware installed at each door. Update each door for all devices installed and connected
    b. Changes to the panel locations
    c. Door numbers
    d. Changes to the schematic connectivity of any system shown on the drawings.
3. Changes to be reflected on the drawings for Audio and Video Systems shall include:
    a. Microphone/speaker faceplate locations and labels.
    b. Rack/cabinet locations.
    c. Speaker and microphone locations.
    d. Rack layout of all components in each rack.
    e. Changes to the schematic connectivity of any system shown on the drawings.
    f. Ceiling/wall mounted projector locations
    g. Label designation of all cables, including system interconnection cables.
4. Changes to be reflected on the drawings for Cabling Systems shall include:
    a. Route of exterior conduits and exterior cabling
    b. Route of backbone cabling, fiber and copper
    c. Route of major cable paths from outlet to comm room.
    d. Rack/cabinet locations.
    e. Faceplate locations
    f. Rack layout of all components in each rack.
    g. Changes to the schematic connectivity of any system shown on the drawings.
    h. Cable numbering for each faceplate.
5. Changes to be reflected on the drawings for Clock System shall include:
    a. Clock Locations

E. Documentation for the specific systems shall include. Provide the following for each system:
1. Contractor warranty dates based on Substantial completion date and contact information for warranty work.
2. Data cabling
    a. Testing Documentation for copper and fiber cabling
        A) Include software to read the test results.
        B) Testing Documentation; This shall include actual cable test results. Tabbed Sections in the binder:
            1) Telecommunication Horizontal Cabling Detailed cable test reports
            2) Telecommunications Fiber backbone cabling
            3) Summary report
    b. Signed Cabling Warranty from manufacturer
3. Video Security
    a. Picture of focused and approved camera image labeled with the camera number and IP address
    b. Master user password list
    c. Spreadsheet of each camera that shall include:
        A) Camera Part number
        B) Firmware revision
        C) IP address
        D) MAC Address
        E) Camera Name
        F) Building where it is located
    d. Training “Cheat Sheet”
    e. Manufacturers Camera Warranty
    f. Server/NVR Warranty
    g. Manufacturer contact information for warranty work
    h. Software Upgrade Protection (SUP) warranty including end date

i. Warranty certificate for all PC's

4. Access Control
   a. Part list/diagram for each access control panel. To include
      A) Panel name and IP address (if applicable)
      B) Doors which are connected to this panel
      C) Panel location. Building and room number
   b. Diagram showing which devices and doors that are attached to each panel. Diagram shall be something like below. Group in PDF document per panel. Label the document with building and panel number. Ensure panel in the field has corresponding panel number



   c. Training "Cheat Sheet"
   d. Server Warranty
   e. Software Upgrade Protection (SUP) warranty including end date
   f. Warranty certificate for all PC's

5. Audio / Video Systems
   a. Warranty certificate for LCD Monitors
   b. Warranty certificate for projectors

F. Training sign-in sheets detailing what was trained, who was trained and their time in training.

END OF SECTION 28 7200

SECTION 28 7600 – TECHNOLOGY LABELING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This section provides direction on labeling of cables and devices.

PART 2 - PRODUCTS

2.01 CABLE LABELING PRODUCTS INTERIOR

A. UTP/STP, access control and audio / video cabling
   1. Laser-printed, self-adhesive wrap around shall be Brady LAT-18-361 or equivalent.
   2. Label shall be 1.00-inch width x 1.33 inch high.
   3. Labels shall come on a sheet with 7 labels per row with a white and transparent matte finish.
   4. Sheet size shall be 8-1/2 inch x 11 inch.
   5. Printable area shall be a minimum of 1.00-inch width x 0.50 inch high.
   6. All labels shall be printed through a laser printer using labeling software.
   7. The Contractor shall submit a proposal for the labeling scheme for all audio and video wiring. The Engineer shall approve of the scheme prior to all labeling.

B. Wireless Access Point Cables in drop ceilings
   1. Install a yellow adhesive sticker to the drop ceiling grid at all WAP cables where the cable is coiled above a drop ceiling.
   2. Size to fit on the ceiling grid. Shall be yellow with black words. See below:
   3. **WAP CABLE ABOVE**

C. Audio and Video Components in a cabinet or rack or teacher desk/lectern.
   1. Each of the audio and video components shall be labeled.
   2. The labels shall have a white background with black, laser printed letters.
   3. Each label shall be large enough for 2 lines of text and wide enough to detail what each dial and component is for.
   4. Each input and output control point on the amplifiers and other equipment shall be labeled for the device to which it connects.
   5. Mark each volume or level control for the optimum setting.
      a. Put a mark at the nominal input and output level for each control. This shall be useful for a new person to reset the system to work as designed if someone else has changed the settings.

D. Fiber Cable labeling.
   1. Laser-printed, self-adhesive wrap around labels for and fiber cables in the comm rooms and ay the back of the patch panels shall be Brady LAT-19-361 or equivalent.
      a. Label shall be 1.00-inch-wide x 3.167 inch high.
      b. Labels shall come on a sheet with 7 labels per row with a white and transparent matte finish.
      c. Sheet size shall be 8-1/2-inch x 11 inch.
      d. Printable area shall be 1.00-inch-wide x 0.97 inch high.
      e. All labels shall be printed through a laser printer using labeling software.
      f. Install on fiber cable at the patch panel as it enters and at the coil of fiber on the wall or in the cable ladder
   2. Fiber panel labels
      a. All fiber optic patch panels shall be equipped with an adhesive, engraved lamacoid label that shows the type of fiber cable, quantity of strands and far end termination point.
      b. Label shall also detail which comm room the fiber originates in.
      c. Example is below:

d. 

e.

f. Where required, provide a blank SFP module to mount the label.

3. Interior exposed fiber cable and fiber cable inside inner duct shall be labeled every 100 feet, label shall be Panduit No. PST-FO.
   a. Label shall be covered with a clear laminate to protect the legend of the label.
   b. Attachments for tie wraps shall be available on the label to attach it to the cable or inner duct.

E. Faceplate Labels
1. Laser-printed, paper labels shall be used to label user faceplates.
2. Individual paper labels shall be installed behind the clear plastic strips of all user faceplates and surface mount housings.
   a. The labels shall show the location identifier number and letter of each individual cable.
3. Where a faceplate or surface mount box does not have a clear plastic strip the contractor shall install an adhesive label on the plate or surface mount box showing the cable number of each cable in the plate.

F. CAT-6/6A patch panels in comm rooms
1. Laser-printed, labels shall be used to label Cat-6 Patch panels
2. Label the side of the patch panel for the panel number in the comm room. “Panel A” etc. label on two spot on each panel
3. The panels shall be labeled 1-24. Use factory numbering or paper numbering if no factory numbering is provided.

G. Rack and Cabinet labels
1. Provide and install Engraved, lamacoid labels at the top of each rack or cabinet installed. Shall be black label with white engraved letters
2. Shall be 1” high minimum.
3. Coordinate rack number and comm room number prior to ordering
4. Sample:

a. COMM RM A1- RACK 01

H. Custom Faceplates
1. Engraved labels shall be installed at locations including but not limited to:
   a. Audio and Video special input plates. Detail each input and output
2. Size the phenolic labels for their individual uses. Provide a sample to the Engineer for approval prior to ordering or installation.

2.02 SECURTY CAMERA LABELING

A. Laser-printed, labels shall be used to label all Security Cameras
1. Label the camera with a White or Clear label with black lettering.
2. Label shall include the camera number.
3. May include the IP address. Consult with owner to determine if this is required
4. Label shall be a minimum of 3/4 inch tall and legible when standing beneath or near the camera as long as camera is not above 15; AFF

2.03 ACCESS CONTROL PANEL LABELING

A. Label the front of each access control panel to detail the doors that are connected to the panel.
   1. Label the front panel and detail each door number
   2. Label shall include the panel name and IP address
   3. Text shall be a minimum of 3/8 inch tall
   4. White label with black numbers

PART 3 - EXECUTION

3.01 PREPARATION

A. Terminate all cables in proper color code sequence.
B. Clean any surfaces where an adhesive label is to be installed.
C. Prior to beginning the work, the contractor shall submit to the engineer a plan for labeling all the cables. This shall take into account to what components each cable is connected.

3.02 GENERAL LABELING

A. Everything shall be labeled as per the specs and drawings.
B. All labels shall be installed to more easily identify the cables and ports on all panels. If there are any questions regarding labeling, contact the Engineer prior to installation.
C. Engraved lamacoid labels shall be provided and installed whenever there is no location for paper inserts on faceplates, power poles, poke thru's, floor boxes, modular furniture and surface raceway.
   1. Engraved lamacoid labels shall provide the same labeling as the paper inserts, but they shall be self-adhesive.
   2. These labels shall be adhered to the location closest to the modular jack.
   3. Individual letters shall be provided for each cable. An overall location identifier can be provided for all the cables at that faceplate or floor box.
   4. Engraved labels for rack shall be at least 1-1/2 inch high with letters 1 inch high.
   5. These labels shall be affixed to the top and front of each rack or cabinet. Verify that the label will fit the rack or cabinet prior to purchasing.

3.03 DATA CABLING LABELING EXECUTION

A. Cable labels for CAT-6 user cables from the faceplate to the patch panel shall be installed within 4 inches of the end of the cable sheath.
   1. The location identifier is made up of 3 fields, and a sample might look like this:

      A-X-YY

      The A stands for the communications room where the cables are terminated.
      The X represents that the Patch panel in that comm. room.
      The YY represents the cables number in that panel 01-48.

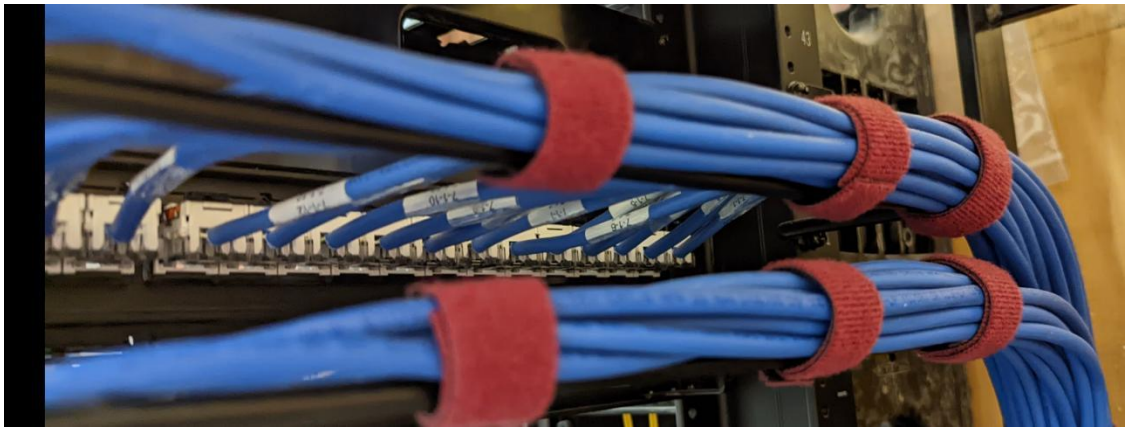
      This system of identification provides the Owner with an easy way to keep track of cables, and where they are located or terminated.

   2. The cable label shall be similar to the label below:

A-X-YY
A-X-YY
A-X-YY

3. Provide a sample label to the Engineer for approval prior to installation of all labels.
4. Labels shall be installed at each end of each cable. Shall be within 4” of the termination.
5. Shall be at a uniform distance from termination on the patch panels. See pic below:

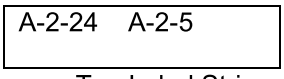






B. Paper inserts shall be supplied for all faceplates and patch panels labels.

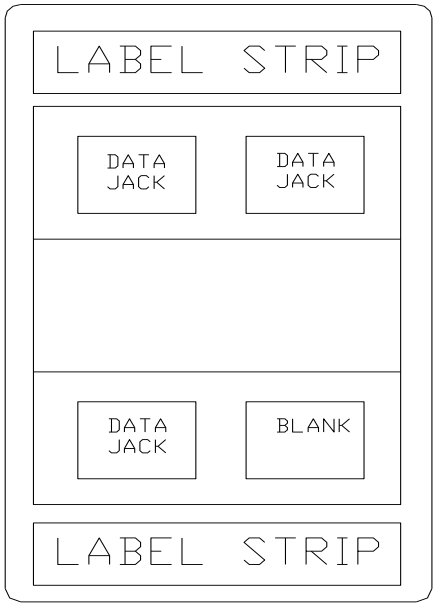
1. Paper inserts for the faceplate shall detail the exact location identifier for each cable.
2. They shall fully cover the background of the insert space on the faceplate, but all numbers and letters of the identifier shall be visible after installation of the plastic cover plate.
3. The paper insert for a standard faceplate will look like this:



Top Label Strip



Bottom Label Strip



4. Provide a sample label to the Engineer for approval prior to installation of all labels.

C. CAT-6 Patch panels shall be labeled for the panel they are numbered in the comm room and for the cameras (1-24 or 1-48)
1. See below diagram:
   a. Install labels at each end detailing the panel number.

Panel A	01	02	03	04	05	06	07	08	09	10	11	Panel A

D. CAT-6 Patch panels for Wireless Access Points shall be labeled for the WAP number
1. See below diagram:
   a. Install labels below each outlet on the patch panel detailing the WAP number
   b. Meet with the owner and obtain the WAP number and label the panel with that WAP number. Install .laser printed label

c. Example below shows WAP number of BU (for Butler building)-0XX etc.

Panel A	01	02	03	04	05	06	07	08	09	10	11	Panel A
	BU-021	BU-022	BU-023	BU-024	BU-025	BU-026	BU-027	BU-028	BU-029	BU-030	BU-031	

TYPICAL PANEL LABELING



3.04 FIBER OPTIC CABLING LABELING EXECUTION

A. Fiber optic cables shall have a wrap around label at each end that details the 2 buildings and/or closets where the cables terminate.
   1. A fiber cable with 12MM strands terminates in White Hall Room 012 and Green Hall Room 243. The wrap around label shall look like this:

12MM
WT 012-GR 243

   2. The wrap around labels shall be installed within 12 inches of the end of the sheath of the copper and fiber cables.
   3. Provide a sample label to the Engineer for approval prior to installation of all labels.

B. Label the fiber optic stowage ring with the information on the fiber cable
   1. Provide a laminated label in the center of the fiber optic stowage ring that details each fiber cable and its fiber type, strand count and far-end termination of each fiber cable.

C. Fiber Panel labeling shall be done for the front of each fiber optic patch panel.

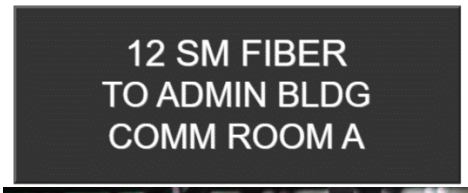
1. The figure below demonstrates the layout of the fiber panel label. Each label shall be customized for each individual panel. The figure below is for the 72 port panel.
2. Contact the Engineer with questions on the correct labeling prior to installation.

12 SM TO HIGH SCHOOL						12 MM TO COMM RM “B”						12 SM TO COMM RM “C”					
01	03	05	07	09	11	01	03	05	07	09	11	01	03	05	07	09	11
02	04	06	08	10	12	02	04	06	08	10	12	02	04	06	08	10	12

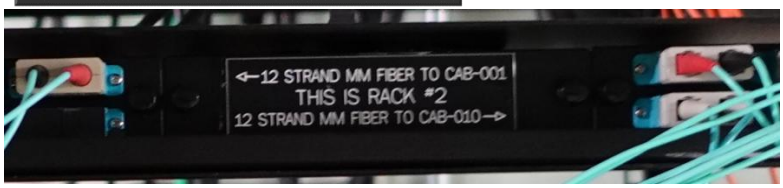
Figure A – Label for 36 Port Fiber Patch Panel

D. Fiber panel labeling shall be completed with an engraved plastic labels.
1. Labels shall detail the fiber type, quantity of strand and far end termination building and comm room
2. Sample:

a.



b.



3.05 VIDEO SECURITY LABELING

A. Cameras shall be labeled with the camera number in a visible location.
1. Affix a label to the camera housing that details the camera number
2. Shall be in a location that is visible from a standing position.
3. Shall be laser printed.
4. Label the camera cable patch panel to include the number of each camera connected to that cable. This camera cable label at the patch panel shall be by video security contractor
   a. Install an adhesive sticker below the cable in the patch panel as the factory number (1-24) is most likely on top of the panel.

B. Label the CAT-6 Patch Panel for security Cameras in each comm room
1. Install an adhesive label on each port on the patch panel that attached so the security camera cable.

   DDD = the camera number within that building

C. CAT-6 Patch panels for security cameras shall be labeled for the camera number
1. See below diagram:
   a. Install labels at each end detailing the panel number.

Panel A	01	02	03	04	05	06	07	08	09	10	11	Panel A
	101	102	107	108	201	105	208	145	146	147	174	

D. All labels shall be installed to more easily identify the cables and ports on all panels. If there are any questions regarding labeling, contact the Engineer prior to installation.

3.06 ACCESS CONTROL SECURITY LABELING

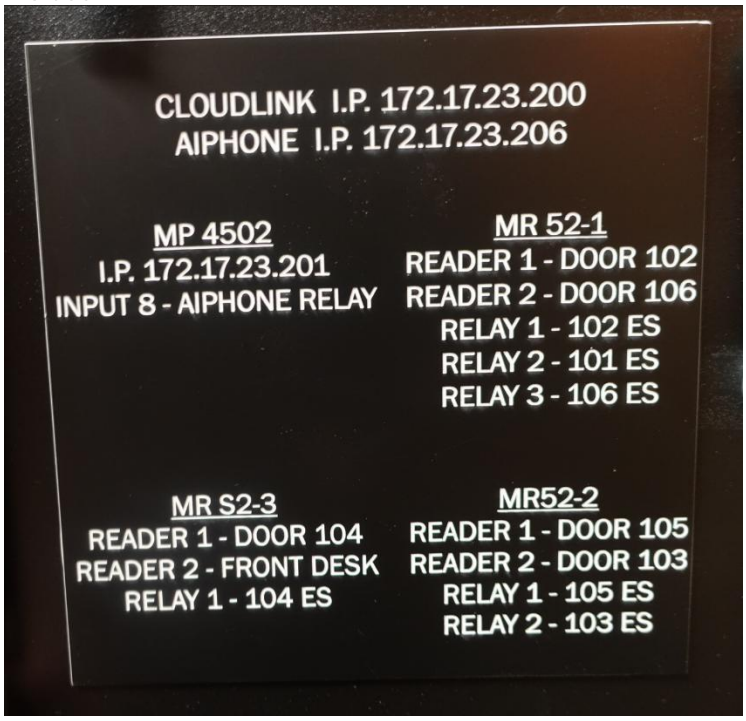
A. Security Panels shall be labeled on the outside to indicate panel number and communications room number

Security panel	IP address 111.111.10.112
Panel 04	Comm room XXX

1. Install a label on the inside of the panel that details:
   a. Door numbers that are connected to this panel
   b. Diagram of panel showing where each door is connected to the panel.
   c. Panel name as shown in the access control system
   d. IP address of the panel

B. Access Control cables shall be labeled.

1. The cables at the door devices shall be labeled where they connect to the device at the door



2.
3. The cables at the panels in the communications rooms shall be labeled with the door number
4. Cable labels shall be installed within 3 inches of the end of the cable sheath.
   a. The cable label shall be similar to the label below:

125A-DC
125A-DC
125A-DC

b. Provide a sample label to the Engineer for approval prior to installation of all labels.

125A-DC

The 125A stands for the Door Number.
The DC stands for Door Contact. This could be any of the field devices: RX,ES, EL, MX, KP etc.

3.07 AUDIO/VIDEO LABELING

A. The Contractor shall make up a spreadsheet listing each audio and video cable that extends from the cabinet/rack to a location within the building.
   1. The spreadsheet shall detail the number of the cable, the room it is located in, and the cabinet to which it routes.
   2. One line on the sheet shall show the results of the test. After being tested for continuity, and being tested that the cable delivers the required signal, the Contractor shall enter “PASS” into the result column.
   3. There shall be spaces for the name of the person doing the test, the date, and the company name.
   4. All information on the sheet shall be printed by a printer except the name of the person performing the tests, the date, and the “PASS” column.
   5. This spreadsheet shall be submitted to the Engineer and Owner prior to project completion.

B. Each control, audio, video, speaker, and microphone cable shall be labeled with a self-laminating, laser printed label at each end. This includes all interconnection cables.
   1. The cables shall be labeled for the equipment that the cable connects Consult with the Engineer prior to labeling.
   2. All speaker cables shall be marked according to their location in each room. Consult with the Engineer prior to labeling.
   3. Each video cable shall be labeled according to the equipment it connects to.
   4. The cable label shall be similar to the label below:

SPKR-1
SPKR-1
SPKR-1

      a. The above label details that this cable is the first speaker cable for the audio system. The same rationale will be used for speakers, video cables, etc. The Contractor shall mark all as-built drawings to show the microphone location or speaker that the label refers to. There shall be continuity between all labels and as-built prints.
      b. Provide a sample label to the Engineer for approval prior to installation of all labels.

C. Once the system is set up and running, many different people will be using the system. The Contractor shall label each audio and video component for what it does.
   1. In example, the mixers shall detail what microphones they mix. Do this by labeling each gain control dial on the mixer. The mixer would be labeled as “Microphone-Mixer in Incident room” or other similar label.

2. For the description of all the components, consult with the Engineer. All labels shall be laser printed.
3. The Contractor shall identify each item on the as-built connectivity drawings. Use the same identification as you do on the labels.

END OF SECTION 28 7600

SECTION 28 7700 – TECHNOLOGY TESTING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This section provides direction on
   1. Testing of copper and fiber cable,
   2. Testing and commissioning of the technology systems

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved vendors for cable testers are:
   1. Fluke or equal

2.02 TESTING PRODUCTS

A. Category 6/6A cable shall be tested.
   1. Cable tester shall support Cat 6 channel and permanent link certification.
   2. Tester shall provide accuracy beyond TIA level III requirements traceable to laboratory reference standards.
   3. Through add on fiber optic probes, the tester shall be able to test multimode and single mode fiber cable.
   4. Test results shall be able to be stored on internal or removable compact flash memory cards.
   5. Tester shall have optional talk set for discussions over the cable being tested.
   6. Tester shall support a frequency range of 1-350 MHz with accuracy to the current proposed TIA Level III.
   7. Tester shall support the following tests:
      a. Near end crosstalk (NEXT).
      b. Attenuation.
      c. Equal level far end crosstalk (ELFEXT).
      d. Return loss.
      e. Ambiant noise.
      f. Wire map shall identify miswires, shorts, opens, reversals, and split pairs.
      g. Shall measure cable length and distance to faults (if any).
      h. Propagation delay.
      i. Loop resistance.
   8. Tester shall support the following test standards:
      a. TIA Cat 6 and ISO Class E.
      b. TIA Cat 5.
      c. TIA TSB-95.
      d. TIA Cat 3, 4 and 5 per TIA TSB-67.
      e. UTP, STP, SCTP coaxial and twinax cabling.
      f. IEEE: all Ethernet 802.3UTP and fiber PMD interfaces including 1000BASE-T; other 802.x PMD interfaces including token ring and demand priority.
      g. ATM: All UTP and fiber PMD interfaces.
   9. Tester shall have all required probes and accessories required to perform CAT-6 tests and “Network Tests.”
   10. Tester shall have been recently calibrated (within 4 months), and shall be utilizing the latest software.

B. Fiber Optic Tester:
   1. Fiber cable shall be tested with a light power meter.
      a. Multimode at 850nm and 1300nm, and single mode at 1310nm and 1550nm shall be tested by the light meter.
      b. Power meter testing shall have a range of +20 dBm.

c. Testing at both wavelengths shall appear on the readout at one time for both multimode and single mode.
d. All connector types shall be available for testing.
e. Resolution of testing shall be to 1 foot.

2. All fibers shall be tested prior to any splice (other than pigtails) being closed and secured.

2.03 PUNCHLIST PROCESS

A. The contractor shall be required to go through a punchlist process prior to substantial completion and final completion/payment of each project

B. Contractor shall be responsible for reviewing their own work and checking to ensure it has met the project requirements.

C. The contractor shall:
1. Review your work in each room
2. Review the specifications and drawing and review their work to ensure it meets requirements
3. Create a punchlist document showing what work is not yet done and what as-builts are yet to be completed. Send document to designer.
a. Provide a date when contractor punchlist work will be completed.
4. Schedule a punchlist and substantial completion meeting with designer.
5. Present updated punchlist document to the owner
6. Walk the site with the contractor and demonstrate all systems and review the work completed. Demonstrate how all work is completed

D. Designer will create an “Owner Punchlist” document
1. This will be provided to the contractor
2. Contractor shall review the list, fix/upgrade/replace all equipment and cabling and finish work on the punchlist
3. Return punchlist to the designer showing when the work was fixed/completed and a signature on the sheet showing that the contractor has reviewed each item.

E. Meet onsite with the designer to review the finished work.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Testing shall be completed after fiber is installed inside the fiber patch panel and the fiber panel has been put together.

B. All cables and panels where cables terminate shall be labeled with the cable label or name of each individual cable. Identify how each cable and panel will be labeled.

3.02 CATEGORY UTP/STP CABLE TESTING

A. Cable tests for CAT 6/6A cables shall be provided for each user CAT-6 cable.
1. Prior to beginning the testing, the Contractor shall provide the Engineer with a notice that testing will begin. Written notice shall be given at least 3 business days prior to testing beginning.
2. Tester shall be calibrated each day with manufacturer provided calibration cable.
3. Tests shall be saved under each cables unique location identifier.
4. Contractor shall provide the correct cables and probes specifically for the cable and modular jacks that are being tested.
5. During the test the tester shall be set to check all “Network Tests.”
6. Test results shall be provided in hard copy and soft copy. Along with the soft copy, provide a copy of the software required to read the test results.
7. Contractor shall supply 2 copies of the paper results and 2 copies of the file results.
8. Provide all paper results in 3-ring binders. Binders shall have a cover that shows the job name, job number, building and closet where the cables were tested, and the range in the location identifiers of the cables tests provided.

9. Tester shall be set to match the cable being tested.
10. Contractor is responsible for ensuring that all cables pass the tests. Any cable found not to pass shall be removed and replaced at the Contractor's expense.

B. Multipair cables shall be tested for continuity, miswires, shorts, opens reversals, and split pairs.
1. Provide the test results in the multiple pair cable Test Sheet

3.03 FIBER CABLE TESTING

A. Fiber cable shall be tested with a light meter for end-to-end tests.
1. Prior to beginning the testing, the Contractor shall provide the Engineer with a notice that testing will begin. Written notice shall be given at least 1 week prior to testing beginning.
2. Light meter tester shall be calibrated at the beginning of each day.
3. Light meter test results shall be provided in a spreadsheet format.
4. Contractor shall supply 2 copies of the paper results and 2 copies of the file results.
5. Provide all paper results in 3-ring binders. Binders shall have a cover that shows the job name, job number, building and closet where the cables were tested, and the range in the location identifiers of the cables tests provided. Test reports shall include the following information for each cabling element tested:
   a. Actual measured and maximum allowable attenuation (loss) at the specified wavelengths per Part 2, Section 3 and the margin. An individual test that fails the link criteria shall be marked as FAIL.
   b. Reference method.
   c. Number of mated connectors and number of splices (if any).
   d. Actual length and maximum allowable length per Part 2, Section 3. Any individual test that fails the link length criteria shall be marked as FAIL.
   e. Group refractive index (GRI) for the type of fiber tested, if length was optically measured.
   f. Tester manufacturer, model, serial number, and software version.
   g. Circuit ID number and project/job name.
   h. Link criteria (autotest) used.
   i. Overall pass/fail indication.
   j. Date and time of test.
6. Contractor shall test all user fiber cables to the following limits:
   a. Link attenuation shall be tested in accordance with ANSI/TIA/EIA-526-14A. Reference measurements shall be made in accordance with Method B or equivalent
   b. Multimode loss shall be no more than .6dB per mated connector and shall be no more than 3dB/km at 850nm and 1dB/km at 1300 nm.
   c. Singlemode loss shall be no more than .6dB per mated connector and shall be no more than .5dB/km at 1310 nm and .4dB at 1550 nm.
   d. If the measured loss is above the limits, the Contractor shall take action to fix the cables and get the tests to be below the loss limits.
7. Contractor is responsible for ensuring that all cables pass the tests. Any cable found not to pass shall be removed and replaced at the Contractor's expense.
8. Testing shall be of the optical link. An optical fiber link is defined as the passive cabling network between 2 optical cross connects (patch panels or outlets). This includes cable, connectors, and splices but does not include active components. The link test contains the representative connector loss at the patch panel associated with the mating of patch cords but does not include the performance of the connector at the equipment interface.

3.04 SECURITY SYSTEM COMMISSIONING

A. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
B. Contractor shall submit a request for the Acceptance test in writing to the owner no less than fourteen days prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.
C. During Acceptance test, Contractor shall demonstrate all equipment and system features to the owner. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by the owner.
D. If the contractor has submitted all necessary paperwork and the system seems to be in working order according to the engineer then the system can be considered Substantially Complete after the engineer puts that in writing.
E. Security System Substantial Completion.
    1. The access control system shall be considered substantially complete as soon as:
        a. All doors are connected, configured in the system and are working as required.
        b. All security devices are connected and have been tested and shown to be fully functional. All cables are labeled at each end.
        c. Intercoms are functioning and able to release lock on a door.
        d. All users are entered into the system and all cards/fobs have been distributed.
        e. All locking and unlocking schedules are defined and are working.
        f. User accounts are setup
        g. As-built drawings have been updated to reflect any changes in the connectivity.
        h. All manufacturer literature has been turned over to the Owner.
        i. Maps are setup and populated in the system.
        j. Training has been completed.
        k. Copy of the system configuration has been provided to the owner via a CD or thumb drive.
    2. The video security system shall be considered substantially complete as soon as:
        a. All cameras are connected and functional.
        b. The system is fully configured and recording images as required.
        c. User accounts are setup
        d. As-built drawings have been updated to reflect any changes in the connectivity.
        e. All manufacturer literature has been turned over to the Owner.
        f. Maps are setup and populated in the system.
        g. Training has been completed.
    3. The contractor shall schedule a substantial completion meeting where all security systems shall be demonstrated and shown to be in working order and configured as per the specs and the owner’s requirements.
        a. If the system is deemed to be in working order then the engineer shall sign a letter stating that the systems are Substantially Complete. The system is not Substantially Complete until a letter is provided to the contractor and owner.
    4. After substantial completion the systems shall be in good working order for a period of 30 days.
        a. In the event that the system or systems should fail or not work as required during the 30-day period, the Contractor shall be on site the same day to fix and configure the system to make it work as designed.
        b. A new 30-day period will begin as soon as the system has been demonstrated to be in good working order and the engineer acknowledges in writing that the system has been fixed and is again considered substantially complete.
    5. Once the system has been considered Substantially Complete and has been working for 30 consecutive days with no interruption in service, the system shall be thought of as “Finally Complete.”
    6. Warranty shall begin immediately after the system is deemed Finally Complete.

3.05 AUDIO AND VIDEO SYSTEMS COMMISSIONING

A. Audio/Video System Testing

1. Notice of at least 1 week shall be given by the Contractor to the Engineer and Owner prior to the demonstration of all the audio and video components.
2. The Contractor shall provide a check off sheet of all the audio/video systems that will be demonstrated.
3. The video check off sheet shall include:
    a. Listing of all headend equipment.
    b. Listing of all the display equipment throughout the building.
    c. Listing of all the controls systems for the video.
    d. Include a short synopsis of the video system and the requirements for channels, viewing, switching, and control.
    e. There shall be space for the Engineer and Owner to check off that each feature has been demonstrated and has been shown to work. Additional space shall be provided at the bottom to note items that do not work or need to be fine-tuned.
4. The audio check off sheet shall include:
    a. Listing of all specialty audio system in different rooms throughout the building.
    b. There shall be space for the Engineer and Owner to check off that each feature has been demonstrated and has been shown to work. Additional space shall be provided at the bottom to note items that do not work or need to be fine-tuned.
5. For each system demonstrated, the Contractor shall show that each input is seen/heard through the output as required.
    a. Show that volume controls for each system actually do control the volume.
    b. Identify each piece of equipment and show the Owner its use.
    c. Test each video input and display throughout the entire system. Demonstrate connectivity to the CATV distribution system and show that the digital signage system is connected and working.
    d. Show that all channels are available as well as any internal input such as DVD players and video camera signals.
    e. Show that these systems can be controlled by a central control panel if the system is so equipped.
    f. Demonstrate connection of the desktop PC and audio to overhead projectors. And LCD displays.
    g. Demonstrate that each wired connection to the overhead projector works and demonstrate how to switch between inputs with the remote control.
    h. If a video switcher is installed, show its operation, and all its switching capabilities.
6. The check off sheets shall be provided to the Engineer prior to the day of the meeting for review. Any changes required by the Engineer shall be made before the sheet is handed out at the check off meeting.
7. Prior to the check off meeting, all the as-built drawings shall be updated with the latest field data. The as-built drawings shall be used to verify connectivity of all components. The Contractor shall also verify that all cable locations and audio/video components are connected as per the drawings.
    a. As-built drawings shall be available at the check off meeting for review by the Owner and Engineer.
8. As part of the as-built drawings, the Contractor shall provide a printed spreadsheet listing all the video and audio cables that route from a video or audio cabinet to a user location or display unit.
    a. The spreadsheet shall list the cable, the room it terminates in, and its identifying number. Refer to the testing specifications for further details.

B. Audio/Video System Substantial Completion.

1. The Audio/Video system shall be considered substantially complete as soon as:
   a. All systems have been shown to be connected and work as required
   b. All labeling is installed and systems are balanced.
   c. As-built drawings have been updated to reflect any changes in the connectivity.
   d. All manufacturer literature has been turned over to the Owner.
   e. Training has been completed.
2. The contractor shall schedule a substantial completion meeting where all AV systems shall be demonstrated and shown to be in working order and configured as per the specs and the owner's requirements.

END OF SECTION 28 7700

SECTION 28 7750 – TECHNOLOGY TRAINING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes directions for the Contractor regarding training for technology and security systems.

1.02 SYSTEM DESCRIPTION

A. The Contractor shall provide training on all the installed systems.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 GENERAL TRAINING REQUIREMENTS

A. The Contractor shall provide training on all systems installed or upgraded as part of the contract.
   1. The Contractor shall involve the personnel from the Owner's office in the implementation and configuration of the systems.
   2. Prior to the cutover of the system, the Contractor shall work with the Owner on the training that will be provided. The Owner and the Contractor shall schedule the training at a time beneficial to both.
   3. Each system is to have training provided as part of the installation.
   4. Each training session shall include.
      a. This training will give an overview of the capabilities of each system, and the methods to be employed in utilizing the system.
      b. The Contractor shall provide a syllabus detailing what will be discussed at the training, and notes for the Owner to refer to during the life of the system. The notes shall list directions for general use of the system and possible fixes to general issues that could occur.
      c. Training shall include as-built diagrams of the connectivity, a walk-thru of the system, a demonstration of actual user interface with the system, and directions on its general use.
      d. This training is only meant to give an overview of each system. In depth training shall be provided for an in-depth analysis of certain systems as described below.
   5. For all training, the Contractor shall pay all expenses.

B. Create cheat sheets for all systems that the users can keep after the training.
   1. Cheat sheet shall include details on how to use the system.
   2. A copy of the cheat sheet shall be laminated and installed at the system location.
   3. For individual training the contractor shall provide a cheat sheet for each person being trained.
   4. Cheat sheet shall be laminated.
   5. Provide a cheat sheet in each classroom or conference room.
   6. Submit these for approval to the designer and owner prior to training. Have the cheat sheets at the training.

3.02 AUDIO/VIDEO SYSTEM TRAINING

A. Training on the audio/video systems shall be as follows:
   1. Provide training on each type of System installed.
   2. Contractor shall provide a 2-hour in depth training class on the connectivity and use of each type of audio and or audio/video system.

3. Training class shall be on-site utilizing the actual equipment installed as part of the system.
4. The class shall be open to 6 of the Owner's Representatives.
5. The Contractor shall provide handouts at the meeting detailing all aspects of the use of the system. It shall include directions on how to best utilize all components, as well as a checklist of items to go through if something is not working properly.
6. The Owner and Contractor shall meet and decide on the syllabus prior to training.
7. Generate a laminated sheet detailing the sequence and how to use each system in each room. Leave that behind in the room. Provide extra paper copies to the owner.

3.03 LARGE SPACE AUDIO AND VIDEO TRAINING

A. Training on the audio system shall be as follows:
   1. Contractor shall provide two (2) training classes on the following systems:
      a. Fieldhouse AV
   2. Training class shall be on-site utilizing the actual equipment installed as part of the system.
   3. The class shall be open to 6 of the Owner's Representatives.
   4. The Contractor shall provide handouts at the meeting detailing all aspects of the use of the system. It shall include directions on how to best utilize all components, as well as a checklist of items to go through if something is not working properly.
   5. The Owner and Contractor shall meet and decide on the syllabus prior to training.
   6. The first training class shall be scheduled for 4 hours on-site and shall include a complete walk thru of each system. The contractor shall:
      a. Go through each piece of equipment and what it does. Show this piece of equipment on the as-built one line document.
      b. Demonstrate all inputs and outputs.
      c. Show all standard settings for controls on the systems.
      d. Review all control points.
      e. Review power connectivity and system on/off.
      f. Connect systems and inputs.
      g. Demonstrate level control and program changes to the systems
      h. Have the owner turn on the system and shut the system down.
      i. Go through labeling to demonstrate how all labels were numbered.
      j. Demonstrate DSP controls and the PC interface.
      k. Show how to setup wireless microphones
      l. Demonstrate how to setup assisted listening devices.
   7. The second training class shall be scheduled 4-6 weeks after the initial training class. This shall be scheduled for 3 hours on-site. The contractor shall:
      a. Ask if the owner has any questions and if they have had any issues since the last training. Address those issues/questions and demonstrate how the system is setup to work.
      b. Demonstrate all inputs and outputs.
      c. Show all standard settings for controls on the systems.
      d. Review all control points.
      e. Review power connectivity and system on/off.
      f. Connect systems and inputs.
      g. Demonstrate level control and program changes to the systems
      h. Have the owner turn on the system and shut the system down.
      i. Go through labeling to demonstrate how all labels were numbered.
      j. Demonstrate DSP controls and the PC interface.
      k. Show how to setup wireless microphones
      l. Demonstrate how to setup assisted listening devices.

B. The contractor shall be in attendance with one (1) technician for the first two events in this space(s)

1. The contractor shall be on site for 3 hours at each event.
2. The system shall be turned on and tested and the contractor shall assist with setup of all microphones and inputs.
3. The contractor shall train all the owners people on how to setup the system and how to connect all microphones and aux inputs.
4. Go through the entire process of turning on the system, setting all levels and choosing the correct program.
5. The contractor shall be on site with their own radios to immediately engage each other if there is a failure in the system.
6. Stay until the end of the event and help with tear down and shut off the system.

END OF SECTION 28 7750

SECTION 28 7800 – TECHNOLOGY WARRANTY

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes directions for the Contractor regarding system and equipment warranties.

1.02 SYSTEM DESCRIPTION

A. The project is not complete until all paperwork has been provided.

1.03 COORDINATION

A. Coordinate as-built drawings and records with the Engineer and Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide manufacturer's warranty for all equipment installed
B. Provide contractor warranty for workmanship and equipment
C. Provide software upgrade protection (SUP) warranty as detailed in the specifications.

2.02 MATERIALS

A. The Contractor shall provide the following to the owner/designer at Substantial Completion and any updates prior to the issuance of the final payment
   1. Manuals and pamphlets on all electronic equipment.
   2. All spare parts and cover plates for all components of the network.
   3. Red lined set of as-built drawings for the entire project.
B. Updated hard copy and soft copy of the As-Built Documentation. See associated spec section.

2.03 AUDIO-VIDEO ON-GOING SERVICE

A. The contractor shall provide scheduled service for each system listed below for a period of 15 months after substantial completion.
   1. Fieldhouse
B. The contractor shall be on-site for 4 hours with two technicians a minimum of two (2) times within 15 months after Substantial Completion.
C. The site visits shall tentatively be every 7 months and shall be utilized to answer any questions the owner has and fix/updated or change any portions of the system the owner has found is not working properly or wants to work differently.
D. At each site visit the contractor shall:
   1. Fully test each system and test all inputs and outputs.
   2. Test controls for on/off and program control.
   3. Clean all filters in cabinets and equipment.
   4. Check all labels and connectivity of equipment in the cabinets.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall fully examine all components of the system to make sure that all manuals and paperwork are included in the final submittal.
B. Examine all equipment and cabling to ensure that it is labeled as per the drawings and specifications.

3.02 GENERAL WARRANTY

A. Warranty Period shall be 1 year after a signed copy of Substantial Completion. This shall be the Warranty Period.

B. See further specifications for additional warranty requirements that may be longer for certain systems.
   1. Contractor shall be responsible for generating and submitting the Substantial Completion document to the designer for review and signature.

C. Warranty shall include each and every part, cable or software system provided as part of this project. This includes cabling, Networking, Wireless, Audio/Video systems and Access Control and Video Security systems.
   1. During the Warranty Period:
      a. If any part is broken due to a manufacturing defect or installation defect, the Contractor shall fix and/or replace the broken item at their own expense.
      b. If any equipment loses connectivity or fails for any reason the contractor shall be onsite to diagnose and fix or replace equipment and upgrades software.
      c. The Contractor shall also supply all configuration and programming necessary to keep all electronic equipment to the latest revision of software during the warranty period.
      d. If the “system” goes down, and needs configuration to be brought back up, the Contractor shall be liable for any programming or reconfiguration.
      e. During the warranty period, the Contractor shall make the Owner aware of any software upgrades that are available.
      f. Contractor shall install all software upgrades for that warranty period or as detailed below for specific systems.
      g. If the system does not run well during the warranty period the contractor shall be onsite to diagnose and fix the system.

D. The contractor shall be onsite within 24 hours after a call from the owner or designer regarding system or equipment issues.

3.03 EXTENDED CABLING WARRANTY

A. The Contractor shall provide to the Owner a “Link Warranty” on all the components of the voice/data cabling system. This includes all components from the faceplate, through the jacks, cable, and back to the patch panels, not including patch cords.
   1. This shall include Fiber Optic cabling and termination equipment.

B. Cable shall be installed that is covered as part of the complete warranty on the data cabling system. Cable that cannot be covered under the warranty shall not be installed.

C. The warranty shall be provided through the manufacturer of the faceplate, jacks, and patch panels. All components shall be by the same manufacturer.

D. The warranty shall guarantee that if any part or piece of the “Link” is found to be defective for a period of no less than 15 years, then that part or piece shall be replaced or fixed at no cost to the Owner.

E. The Contractor shall be responsible for installing the system in such a manner that the manufacturer will provide this warranty to the Owner.

F. The Contractor is responsible for compiling and submitting all the paperwork required to receive the warranty. This includes gathering all the information, completing any required forms, and submitting these forms and any other records to the manufacturer as required.

G. It shall be the Contractor’s responsibility to receive the approved warranty notification from the manufacturer and provide that and all the associated paperwork to the Owner.

H. The installation shall not be considered finally complete until the Owner has received notification, from the manufacturer, that the entire cabling system is covered by their warranty

3.04 AUDIO/VIDEO ON-GOING SERVICE

A. Entire Audio and Video system shall be warranted for 15 months

B. The contractor shall provide scheduled service for each system for a period of 15 months after substantial completion.

C. The contractor shall be on-site for 4 hours with two technicians a minimum of two (2) times within 15 months after Substantial Completion.

D. The site visits shall tentatively be every 7 months and shall be utilized to answer any questions the owner has and fix/updated or change any portions of the system the owner has found is not working properly or wants to work differently.
E. At each site visit the contractor shall:
   1. Fully test each system and test all inputs and outputs.
   2. Test controls for on/off and program control.
   3. Clean all filters in cabinets and equipment.
   4. Check all labels and connectivity of equipment in the cabinets.
   5. Verify system works as installed.
   6. Make any small configuration changes required by the owner

3.05 SERVER WARRANTY
A. Each Server (Digital Watchdog Camera Server) that is provided as part of this project shall be provided with a seven-year (7) next day replacement warranty.
   1. The warranty shall include that the contractor be onsite and replace the server and any software required.
   2. Coordinate with the manufacturer to facilitate the server replacement.
   3. Re-install the server and connect to the network.
   4. Re-implement the existing owner's software and configure based on the final initial implementation.
   5. Keep a copy of the original configuration of the system to allow easy implementation of the new server.

3.06 CAMERA WARRANTY
A. All cameras shall be warranteed by the manufacturer for 5 years.
B. If camera fails during general warranty period than the contractor shall be onsite and replace camera with a new model. Install replacement camera.
C. After general warranty period the manufacturer shall replace or repair the camera if it fails.

3.07 VIDEO SECURITY SOFTWARE WARRANTY
A. As part of the project the contractor shall provide a three-year (3) video security recording system and security camera warranty that provides for all software updates during the years after Substantial Completion.
   1. Contractor shall be required to install all software and firmware updates during the three years.

3.08 ACCESS CONTROL SOFTWARE WARRANTY
A. As part of the project the contractor shall provide a three-year (3) access control system software warranty that provides for all software updates during the years after Substantial Completion.
   1. Contractor shall be required to install all software and firmware updates during the three years.

END OF SECTION 28 7800

SECTION 32 1723.28 - ARTIFICIAL TURF

PART I – GENERAL

1.01 REFERENCE STANDARDS

A. ASTM D1335 - Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings; 2021.
B. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).
C. ASTM D5823 - Standard Test Method for Tuft Height of Pile Floor Coverings; 2019 (Reapproved 2024).

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.03 SUMMARY

A. The work under this section shall consist of furnishing all labor, materials, and equipment necessary to install, in place, all synthetic turf and other materials as indicated on the plans and as specified herein. The installation of all new materials shall be performed in strict accordance with these specifications, the turf provider's instructions and in accordance with all details and shop drawings.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Submit catalog cuts, material safety data sheets (MSDS), brochures, specifications, preparation and installation instructions and recommendations.
   2. All supplied and installed materials and products will meet or exceed the minimum specifications designated in this section. Sufficient data must be submitted to indicate compliance with the Contract Documents.
   3. Submit instructions for installation.
B. Test Results: The following test results, certified by a licensed independent testing laboratory, shall be submitted as outlined below
   1. With the bid – Mandatory and minimum specifications as shown in Part 2. Bids not meeting the minimum specifications will be rejected.
   2. Upon completion of the installation of the infill (including anti-static applications)— Installer Supervisor must measure and record infill depth using a depth tester for Turf and Tracks with analog or digital readout. At ten separate field locations, three data points should be recorded by measuring the infill depth in a triangular pattern approximately 12" – 18" apart. At each of the ten testing locations, the three data points should be averaged. Any location that does not measure 1.46" in depth or more must be corrected.
   3. At completion of project – Dynamic Cushioning Test according to ASTM F-355-95, Procedure A and Standard F-1936-98 only if the finished product is to be used for American Football.
C. Shop Drawings: Show fabrication and installation details for synthetic turf including, but not limited to:
   1. Proposed locations of all seams in fabric surfacing. Show installation methods and construction.
   2. Field lining and marking - Submit a complete scale and dimensional drawing of inlaid or tufted-in field lines and marking boundaries. Include graphics for end zones and center logo artwork for approval as well.
   3. All submittals shall be provided within 14 days after Notice to Proceed
D. The Turf Manufacturer shall provide the following samples of the artificial turf selected for this project
   1. An 8.5" x 11" minimum sample of the exact synthetic turf and infill system that is specified for this project.
   2. Infill mix in accordance with product specifications

E. Turf Manufacturer Certificates: Certified list of fifty (50) existing installations of a synthetic turf and infill system within the last three years, including Owner Representative and telephone number, attesting compliance with quality assurance information. All must be located within the continental United States.

F. With the bid - Proof that the Turf Manufacturer is a member, in good standing, of the Synthetic Turf Council

G. With the bid – Sample Warranty: Provide a sample pre-paid third party insured warranty with the bid. Policy must be in force at the time of the bid.

1. The Contractor shall provide a warranty to the Owner that covers defects in materials and installation workmanship of the turf for a period of eight (8) years from the date of substantial completion. The turf provider must verify that their representative has inspected the installation and that the work conforms to the turf provider's requirements and any written directives. The warranty shall include general wear and damage caused from UV degradation. Other items that must be addressed include the following:
   a. Acceptable uses for the field
   b. Fading
   c. Color match within specifications
   d. Excessive fiber wear
   e. Wrinkling and panel movement
   f. Shock absorbency (Gmax)
   g. Seam integrity
   h. Drainage (through the turf only)
2. Exclusions shall include the following:
   a. Vandalism
   b. Acts of God
3. The warranty shall be fully third-party insured for the entire 8-Year term and be non-prorated. Warranties that include language which pro-rates benefits shall cause the provider's bid to be rejected. Prior to final payment for the synthetic turf, the Contractor shall submit to the Owner, this policy guaranteeing the warranty to the Owner. Insurance must reflect the following values:
   a. $5,000,000 per each insured warranty
   b. $5,000,000 annual aggregate for all warranties issued during each 12-month period of the 8-Year warranty
   c. Policies that are backed by a Letter of Credit are not acceptable
   d. Policy must be issued by an A- rated or greater A.M. Best Rating
   e. Policies that include self-insurance or self-retention clauses shall not be considered. Policy can not include any form of deductible amount. Policy must be in force at the time of the bid.

H. With the bid – Turf Manufacturer must attest that their submitted products infringe on no known patents.

I. Maintenance and Operations Data: At the completion and acceptance of the project submit 3 complete sets, in manual form, of all the turf provider's recommended procedures and materials for, but not limited to general maintenance, line/marking installation, small repair procedures, cleaning, etc…

J. Project Record Documents: Record actual locations of seams, drains, and other pertinent information in accordance with the General Requirements

1.05 QUALITY ASSURANCE

A. Turf Manufacturer Qualifications

1. Shall be experienced in the installation of synthetic infill grass (including in-house factory extruded RootZone® fiber) for a minimum of five (5) years.
2. Shall have a minimum of 500 full sized tall fiber infilled type field installations. Field size to be a minimum of 65,000 sq feet to qualify. This list is to be provided with the bid.
3. Shall provide third party certification confirming compliance with referenced standards.

4. Turf Manufacture must formulate and produce its own fiber master batch.

B. Installer Qualifications:
   1. Installation team shall be an established, insured installation firm experienced as a premium turf installer with suitable equipment and supervisory personnel, with a minimum of five years' experience with 15-foot-wide tufted materials.
   2. Installation team shall be trained and certified, in writing, by the turf manufacturer, as competent in the installation of the specified material, including seaming and proper installation of the infill mixture.
   3. Site superintendent shall have at least 10 installations that are similar to this type of tall fiber synthetic turf system.

C. All components and their installation method shall be designed and manufactured for use on outdoor athletic fields. The materials as hereinafter specified, should be able to withstand full climatic exposure, be resistant to insect infestation, rot, fungus and mildew; to ultra-violet light and heat degradation, and shall have the basic characteristic of flow-through drainage allowing free movement of surface run-off through the turf and directly into prepared granular base and into the field drainage system.
   1. The synthetic turf and components shall be of national reputation. The turf fabric shall be installed by factory-authorized and certified technicians.

1.06 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit synthetic turf work to be performed according to Contractor or Turf Provider's written instructions and warranty requirements.

B. Field Measurements: Indicate measurements on Shop Drawings.

1.07 WARRANTY – SPECIAL WARRANTY FOR AMERICAN FOOTBALL: TURF MUST MAINTAIN AN ASTM F 355 GMAX OF LESS THAN 165 FOR THE LIFE OF THE WARRANTY. THIS IS FOR THE ENTIRE WARRANTY PERIOD OF EIGHT (8) YEARS.

1.08 MAINTENANCE SERVICE – TURF INSTALLATION CONTRACTOR SHALL TRAIN MAINTENANCE STAFF AND/OR CONTRACTED MAINTENANCE STAFF IN THE USE OF THE RECOMMENDED MAINTENANCE EQUIPMENT AND PROVIDE MAINTENANCE GUIDELINES TO THE FACILITY MAINTENANCE STAFF.

PART TWO – PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design:
   1. AstroTurf Corporation – AstroTurf® Rootzone 3D3 Blend 52
      a. 2680 Abutment Road, SE
      b. Dalton, GA 30721
      c. P: 706.277.8873
   2. Substitutions: Products other than Rootzone 3D3 Blend 52 are acceptable if in compliance with all requirements of these specifications. Submit alternate products with the bid proposal and provide the following:
      a. Provide all specifications, product data, certification and required information for proposed alternate. It is the responsibility of the bidder to prove that the product substitution is equal to or greater than the product specified.
      b. Provide a sample copy of insured warranty and insurance policy information
      c. Provide a sample (8.5" x 11") of the product substitution
   3. Refer to Section No. 01 6000 - Product Requirements.

2.02 TURF MATERIALS

A. Synthetic Turf System: A complete synthetic turf system consisting of a combination of 10,800 denier monofilament fibers made from a singularly extruded combination of stabilized polyethylene and nylon polymers with proper compatibilizers and 10,000 denier parallel slit film fibers along with an in-house factory extruded monofilament RootZone®. Pile height shall be nominal 2.0". Fibers shall be tufted to a primary backing and a mechanically applied adhesive secondary backing.
   1. The tufted fiber's face weight shall not weigh less than 52 ounces per square yard. The tufted rows of fiber are to be spaced no more than 3/8" apart. ASTM tests proving the fiber meets these qualifications must be provided with the bid. Turf systems that do not meet this specification will be disqualified.
   2. The carpet's primary backing shall have a minimum weight of 6.7 oz per square yard. The carpet shall then be coated with a secondary backing of polyurethane synthetic coating material with a minimum application rate of 20 ounces per square yard and then perforated for adequate drainage. Carpets that are not perforated for adequate drainage shall not be acceptable.
   3. The carpet shall be delivered in 15' wide rolls. The rolls shall be of sufficient length to go from sideline to sideline. Head seams, other than at sidelines, will not be acceptable.

B. The infilled pile surface shall provide good traction in all types of weather with the use of conventional sneaker type shoes, composition molded sole athletic shoes, and screw- in style football cleats.

C. The pile surface shall be suitable for both temporary and permanent line markings using acrylic paint, as per the turf provider's recommendations.

D. All adhesives used in bonding the seams shall be resistant to moisture, freeze/thaw, bacteria and fungus attacks, and resistant to ultraviolet radiation. The adhesive shall be made especially for the adhesion of synthetic turf seams and inlaid field markings and graphics.

E. The seam specific adhesive system shall have been utilized on at least 25 full installations. Provide this information with the bid. It shall consist of a factory-made adhesive bed applied to a non-woven fabric seaming tape. The adhesive bed shall be a metered amount suitable for the application. It shall be heat and pressure activated. A special heat application machine and pressure application using weighted rollers is mandatory.

F. Supply field groomer and sweeper or single maintenance apparatus that performs both basic maintenance functions.

G. Perimeter edge details required for the system shall be as detailed and recommended by the turf provider, and as approved by the turf provider.

2.03 TURF FABRIC SURFACE

A. The pile surface shall resemble freshly mown natural grass in appearance, texture and color.

B. The pile surface shall be nominally uniform in length.

C. The pile fiber angle shall be 90 degrees ± 15 degrees, measured from the horizontal after installation of the infill material.

D. The entire system shall be resistant to weather, insects, rot, mildew and fungus growth and will be non-allergic and non-toxic.

E. The synthetic turf system shall have a nominal fiber length of 2.0".

F. Each roll shall be minimum 15' wide

G. The entire system shall be constructed for porous standards as specified. Synthetic turf system shall be perforated at 4 – 6" on center. Systems that are not perforated for maximum drainage shall not be acceptable.

H. All markings shall be tufted in-place, inlaid or glued. It is recommended that the maximum amount of markings be factory-prefabricated into the turf system prior to shipment to site. At a minimum all football markings (with the exception of hash marks) shall be factory prefabricated.

1. PRODUCT SPECIFICATIONS – TURF

I. Face yarns shall be a proven athletic quality, outdoor stabilized monofilament made from a singularly extruded combination of stabilized polyethylene and nylon polymers with proper compatibilizers.

J. The fabric shall possess the following minimum physical characteristics. ASTM testing shall be provided with the bid and any products not meeting the minimum physical characteristics will be rejected:

1. Average Pile Yarn Face Weight ASTM D 5848 52 oz/square yard
2. Average Total Weight ASTM D 5848 78.7 oz/square yard
3. Secondary Backing Weight ASTM D 5848 20 oz/square yard
4. Primary Backing ASTM D 5848 6.7 oz/square yard
5. Average Tuft Length ASTM D5823 2.0”
6. Tufting Gauge ASTM D 5793 3/8” maximum
7. Tuft Bind ASTM D1335 > 8 lbs
8. Yarn Denier (monofilament fiber) ASTM D 1577 10,800/6
9. Yarn Denier (slit film fiber) ASTM D 1577 10,000/1
10. Yarn Denier (Rootzone fiber) ASTM D 1577 5,600/8
11. Fiber Thickness (Mono/slit-film) ASTM D 3218 330/115 microns
12. Surface Flammability ASTM D2859 TEST PASSED
13. Permeability ASTM F 1551 >30
14. Melt Point ASTM D 789 248 degrees Fahrenheit
15. Gmax System (American Football) ASTM F 355 <125 at installation
16. < 165 over life of
17. warranty

2.04 INFILL MATERIAL

A. Infill composition shall consist of a ballast layer of silica sand topped by ambient SBR rubber performance infill in a ratio by weight of 65% rubber / 35% sand.

B. SBR infill:

1. Must be ambient SBR Rubber
2. Must be a 10-20 sieve size.

C. Immediately after infill layers are installed, infill depth must be measured per testing protocol detailed in Section 1.3 C. 2 above to ensure that infill layer is at least 1.46” deep.

PART 3 - EXECUTION

3.01

A. Prior to installation of the synthetic turf, examine substrates and conditions, with Installer present, for compliance with requirements for visual installation tolerances. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Certification of prior work: The synthetic turf manufacturer and / or certified installation contractor shall perform a visual inspection of the field base onto which the synthetic turf system is to be installed and to examine the finished surface for required compaction, and grade tolerances (through string line testing). After any discrepancies between the required materials, application and tolerance requirements noted have been corrected, the synthetic turf installer should submit a written certification of VISUAL acceptance of the base for installation of the synthetic turf system. Any tests other than VISUAL tests (string line, water hose, etc…) shall be the responsibility of the General Contractor, Architect, Engineer, or Sports Field Consultant.

C. Installation of all materials shall be performed in full compliance with approved project shop drawings. Only factory trained and certified technicians skilled in the installation of athletic caliber synthetic turf systems, working under the direct supervision of the turf manufacturer's project managers, shall undertake the placement of the turf system. The designated supervisory personnel on the project must be certified, in writing by the turf provider as competent in the installation of these materials, including proper seaming and proper installation of the infill mixture. The turf provider shall certify the installation and warranty compliance.

3.02 PREPARATION

A. Inspect delivered field surface fabric and components immediately prior to installation. Any damaged or defective items shall be rejected. Installed synthetic turf system shall be inspected for, but not limited to, the following:
   1. Uniformity of product and color
   2. Surface wrinkles
   3. Field markings
   4. Field Edge installation
   5. Pile height of each roll shall be measured. Any material(s) that does not meet minimum height and thickness specifications shall be rejected. Pile height shall be measured in its finished positions.

B. Environmental Conditions: Weather conditions are important for the successful installation of the systems. No work under this section will proceed when:
   1. Ambient temperatures are below 45 degrees Fahrenheit.
   2. Material temperatures are below 45 degrees Fahrenheit.
   3. Surfaces are wet or damp
   4. Rain is imminent or falling.
   5. Conditions exist or are imminent, which will be unsuitable to installation requirements of the systems specified herein. Humidity levels will be inside the limits recommended by the adhesive manufacturer to obtain optimal bonding characteristics of the surfaces.

3.03 INSTALLATION OF THE SYNTHETIC TURF

A. The full width rolls shall be laid out across the field. When all of the rolls of the playing surface have been installed, the sideline areas will be installed at right angles to the playing field turf. All seam widths are to be held to a minimum and shall be traverse to the field direction. Seams shall be flat, tight, and permanent with no separation or fraying. All seams shall remain as required for the duration of the warranty period.

B. The perimeter of the field shall be firmly secured to the edge anchors for the life of the warranty and in accordance to project details.

C. Resilient Infill
   1. The sand ballast infill material shall be spot inspected and tested for conformance to sieve specifications.
   2. Sand ballast Infill must be placed in such a way as to minimize fiber entrapment.
   3. The rubber infill must be uniformly applied so as to ensure uniform, predictable surface.
   4. After infill layers are installed, infill depth must be measured to ensure that infill depth is at least 1.46" deep.
   5. Field Lining and Markings

D. All markings shall be installed in accordance with prior approved project Shop Drawings.

E. Inlays shall conform to the turf manufacturer's specifications, directions, and recommendations for the best results.

F. Striping layouts shall be accurately measured by the Contractor before installation of inlaid field markings

G. Install inlays only when the surface is completely dry. Adhere all inlays securely into place. Never loose-lay and sew an inlay into place.

1. FIELD QUALITY CONTROL—Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

H. Testing Services: Testing and inspecting of completed applications of synthetic turf system shall take place in suggestive states, in areas of extent and using methods that are industry standard. Do not proceed with application of next stages until test results for previously completed applications show compliance.

I. Remove and replace items where test results indicate that it does not comply with specified requirements.

3.04 FINAL ACCEPTANCE

A. Upon final acceptance, the Manufacturer shall submit to the Owner three (3) copies of Maintenance Manuals, which will include all necessary instructions for the proper care and preventative maintenance of the synthetic turf system, including painting and striping.

B. The finished playing surface shall appear as mowed grass with no irregularities and shall afford excellent traction for conventional athletic shoes of all types. The finished surface shall resist abrasion and cutting from normal use.

3.05 CLEANING

A. Contractor shall provide the labor, supplies and equipment as necessary for final cleaning of surfaces and installed items. All usable remnants of new material shall become the property of the Owner. The Contractor shall keep the area clean throughout the project and clear of debris. Surfaces, recesses, enclosures, etc… shall be cleaned, as necessary, to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

END OF SECTION 32 1723.28

APPENDIXES

APPENDIX 1

Geotechnical Investigation

Dated December 29, 2025



REPORT ON GEOTECHNICAL INVESTIGATION

2025 DEXTER SCHOOLS BOND PROGRAM

DHS FIELDHOUSE AND SITE IMPROVEMENTS AND AL RITT STADIUM LIGHTING

DEXTER, MICHIGAN 48130

LATITUDE 42.324878° N
LONGITUDE 83.89651° W

CONSULTING GROUP

Prepared for:

Granger Construction
6267 Aurelius Road
Lansing, Michigan 48911

G2 Project No. 253566S
December 29, 2025

CONSULTING GROUP
Smart.Results.Fast.

December 29, 2025

Mr. Greg Brand, P.E.
Senior Project Manager
Granger Construction
6267 Aurelius Road
Lansing, Michigan 48911

RE: Report on Geotechnical Investigation
2025 Dexter Schools Bond Program
DHS Fieldhouse and Site Improvements and Al Ritt Stadium Lighting
Dexter, Michigan 48130
G2 Project No. 253566

Dear Mr. Brand:

We have completed the geotechnical investigation associated with the 2025 Dexter Schools Bond Program, which includes construction of the proposed fieldhouse athletic building and site improvements at Dexter High School, as well as the construction of stadium lighting at Al Ritt field. This report presents the results of our observations and analyses, as well as recommendations related to earthwork, subgrade preparation, foundation design, bituminous pavement design, in-situ infiltration, and related construction considerations.

We appreciate the opportunity to be of service to Granger Construction and look forward to discussing the recommendations presented. In the meantime, if you have any questions regarding the report or any other matter pertaining to the project, please call us.

Sincerely,

G2 Consulting Group, LLC

Ryan P. Carpus, P.E.
Project Engineer

Jennifer M. Casey, P.E.
Project Consultant

Tyler S. Hesse, P.E.
Project Manager

RPC/TSH/JMC/tsh

G2 CONSULTING GROUP, LLC
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HEADQUARTERS
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248.680.0400

ANN ARBOR
1350 Eisenhower Place, Ann Arbor, MI 48108
734.390.9330

EXECUTIVE SUMMARY

We understand the proposed project consists of constructing a new fieldhouse, pavements, a detention pond, and two (2) underground stormwater management structures at Dexter High School and new lighting at Al Ritt Stadium.

Approximately 2 to 10 inches of topsoil or 12 to 24 inches of crushed limestone aggregate are generally present at the ground surface of the soil borings. Within soil borings B-21 and B-22, B-28, B-31, B-33, B-37, and B-38, stiff to very stiff cohesive fill soils and very loose to medium compact granular fill soils underlie the topsoil and extend to approximate depths ranging from 3 to 6 feet. In general, the native soils consist of alternating strata of very loose to compact granular and stiff to very hard cohesive soils, extending to the explored depths ranging from 10 to 35 feet below grade. Groundwater was encountered at approximate depths ranging from 5 to 20 feet below existing grade within borings B-21 through B-29, B-31, and B-36 through B-39. Upon completion of drilling operations, the groundwater level within these borings was measured at depths ranging from 6 to 29 feet below grade. No measurable groundwater was observed during or upon completion of drilling operations within borings B-30 or B-32 through B-35. The rise in the groundwater level above the encountered elevation within soil borings B-22, B-23, and B-31 may be indicative of an artesian condition.

The fill soils noted above do not appear to have been placed in an engineered manner and have organic matter contents ranging from 4.3 to 7.0 percent. Considering the existing ground surface elevations and the fieldhouse FFE, we anticipate the fill soils within the influence of the fieldhouse will be removed while adjusting site grades to achieve the design subgrade elevation. In addition, based on proposed pavement finished grades, we anticipate the existing fill soils will be removed during grading operations in the vicinity of soil borings B-28 and B-31. Some existing fill soil may remain beneath the proposed pavement section within the vicinity of soil boring B-33. The fill within soil boring B-33 does not contain any notable organic matter and is generally considered suitable for support of the pavement, following the successful completion of a proof-roll/proof-compaction evaluation.

We recommend the fieldhouse be supported by shallow conventional strip and/or spread footings designed to bear at a minimum depth of 3-1/2 feet below finished grades within the native loose to medium compact granular soils, very stiff to hard cohesive soils, or engineered fill. Foundations bearing within the above mentioned soils can be designed based on a net allowable bearing capacity of 2,500 psf. Recommended soil design parameters for drilled pier foundations for the light poles are provided in the FOUNDATION RECOMMENDATIONS section of this report. If the recommendations outlined in this report are adhered to, total and differential settlements for the completed structures should be within 1 inch and ½ inch, respectively. We expect settlements of these magnitudes are within tolerable limits for the type of structures proposed.

No significant groundwater accumulations are anticipated in construction excavations for the proposed fieldhouse, utilities, or stormwater BMPs. We anticipate any groundwater seepage or surface runoff can be controlled with a properly constructed system of sumps and pumps.

Caving and/or sloughing of the granular soils will occur during drilled shaft excavation operations. In addition, groundwater was encountered at depths ranging from 5 to 7 feet below existing grade. Therefore, the drilled pier contractor should come to the site prepared to use temporary steel casing to maintain a stable excavation and seal off groundwater. The contractor should also come to the site prepared to break-up and remove any cobbles encountered in the excavation and may need a rock auger to excavate through the very hard cohesive soils.

Do not consider this summary separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.

PROJECT DESCRIPTION

We understand the proposed project includes construction of a new fieldhouse with associated site improvements at Dexter High School (DHS) and new stadium lighting at the Al Ritt Stadium near Creekside Intermediate School. The site improvements at DHS will include the construction of bituminous concrete pavements, site concrete, utilities, and structural best management practices (BMPs) consisting of a detention pond and two (2) underground stormwater management structures.

We understand the fieldhouse will be constructed to the south of the existing twin turf fields located within the southwest quadrant of the DHS campus. The fieldhouse will be a single-story, slab-on-grade structure with a height of 61 feet, an approximate footprint of 63,072 square feet, and a finished floor elevation (FFE) of 887-1/2 feet. The northern portion of the structure will include an interior mezzanine. Information regarding structural loading conditions associated with the fieldhouse was unavailable at the time of this report. It is assumed that the structure will have column loads ranging from 75 to 150 kips and wall loads ranging from 3 to 5 kips per foot.

Based on the topographic survey provided, existing site grades within the vicinity of the fieldhouse range from elevation 882 to 894 feet. As the fieldhouse will have a FFE of 887-1/2 feet, we anticipate existing grades will be lowered by as much as 6-1/2 feet and raised by as much as 5-1/2 feet to achieve the design subgrade elevation.

We understand that a bituminous concrete service drive and parking areas will be constructed around the perimeter of the fieldhouse. Information regarding anticipated traffic frequencies throughout the pavement areas was unavailable at the time of this report; however, we understand a heavy-duty pavement is proposed. Based on the provided Dexter High School Field House Schematic Design Grading Plan dated October 2025, Sheet C402, pavement grades west of the fieldhouse will be approximately 6 to 8 feet lower than existing grades, pavement grades east of the fieldhouse will be approximately 12 feet higher or 7 feet lower than existing grades, and pavement grades along the service drive leading to the parking areas will be similar to existing grade at the east and west ends of the drive and will be as much as 7 feet lower than existing grades along the remainder of the alignment.

Based on the drawings provided, we understand that four (4) new stadium light poles will be constructed along the perimeter of the Al Ritt Stadium football field. The light poles will have heights of 80 to 90 feet above grade. The loading conditions for the stadium lighting poles were not available to us at the time of this report; however, we assume the poles will be supported using drilled shaft foundations. Based on the "Electrical New Work Site Plan" drawing by Peter Basso Associates, dated October 31, 2025, we understand electrical conduit will be installed via directional drilling methods beneath the athletic field at a minimum depth of 10 feet below current grades.

G2 Consulting Group, LLC (G2) was provided a Geotechnical Report prepared by Driesenga & Associates, Inc. (D&A) Project No. 2520656.3A, dated August 12, 2025. The D&A report was completed during the preliminary design stage for the project. D&A soil borings SB-1, SB-2, and SB-3 lie within the vicinity of the proposed fieldhouse. These boring logs are included in the Appendix of this report are have been used in development of the recommendations contained herein.

If information related to existing/final site grades, structural loading conditions, finished floor elevation, and/or anticipated traffic frequencies change or become available, G2 should be notified to re-evaluate the recommendations provided herein, if necessary. The purpose of our exploration is to determine and evaluate the general subsurface conditions at the above-mentioned locations and to develop recommendations for earthwork, subgrade preparation, foundation design, bituminous pavement design, and in-situ infiltration, as well as construction considerations as they relate to the geotechnical conditions on site.

SCOPE OF SERVICES

The field operations, laboratory testing, and engineering report preparation were performed under direction and supervision of a licensed professional engineer. Our services were performed according to generally accepted standards and procedures in the practice of geotechnical engineering in this area. Our scope of services for this project is as follows:

1. We performed a total of nineteen (19) soil borings throughout the above mentioned areas. Soil borings B-21 through B-26 per performed within the influence of the proposed fieldhouse extending to a depth of 25 feet each. Soil borings B-27 through B-35 were performed within the vicinity of the proposed pavement areas, detention pond, and underground stormwater management system, extending to depths ranging from 10 to 20 feet. Soil borings B-36 through B-39 were performed within the vicinity of the stadium light poles extending to depths ranging from 30 to 35 feet.

2. We performed laboratory testing on representative samples obtained from the soil borings. Laboratory testing included visual engineering classification, natural moisture content, organic matter content, Atterberg limits, and unconfined compressive strength determinations.

3. We prepared this engineering report. The report includes recommendations regarding earthwork, subgrade preparation, foundation design, bituminous pavement design, in-situ infiltration, and related construction considerations.

FIELD OPERATIONS

G2, in conjunction with Granger Construction, selected the number, depths, and locations of the soil borings. The boring locations were determined in the field by a G2 representative using GPS assisted mobile technology and by measuring from known surface features using conventional taping methods. The approximate soil boring locations are shown on the Soil Boring Location Plans, Plate Nos. 1 and 2. A topographic survey detailing existing surface grades at the soil boring locations associated with the DHS fieldhouse and parking lot, titled "Topographic Survey" by Arbor Land Consultants and dated October 30, 2025, was used to interpolate ground surface elevations at the boring locations. If more precise ground surface elevations are required, we recommend the as-drilled ground surface elevations at the boring locations be determined using traditional survey techniques.

Prior to soil borings operations, we subcontracted a tree clearing company to provide access pathways to the soil boring locations within the wooded areas located near the southwest corner of the DHS campus. The soil borings were performed using an all-terrain vehicle (ATV) mounted drilling rig. Continuous 2-1/4-inch, inside-diameter, hollow-stem augers were used to extend the boreholes to the explored depths. Soil samples were collected at 2-1/2-foot intervals within the upper 10-feet and at 5-foot intervals thereafter. The samples were obtained using the Standard Penetration Test (SPT) method (ASTM D1586), which involves driving a 2-inch diameter split-spoon sampler into the soil with a 140-pound weight falling 30-inches. The sampler is generally driven in three (3) successive 6-inch increments with the number of blows for each increment recorded. The number of blows required to advance the sampler the last 12-inches is termed the Standard Penetration Resistance (N). The blow counts for each 6-inch increment and the resulting N-value are presented on the soil boring logs.

The soil samples were placed in sealed containers and brought to our laboratory for testing and classification. During field operations, the driller maintained logs of the subsurface conditions, including changes in stratigraphy and observed groundwater levels. The final boring logs are based on the field boring logs supplemented by laboratory soil classification and test results. The boreholes were backfilled with auger upon completion of drilling operations.

LABORATORY TESTING

Representative soil samples were subjected to laboratory testing to determine soil parameters pertinent to subgrade preparation and foundation design. An experienced geotechnical engineer classified the samples in general conformance with the Unified Soil Classification System. Laboratory testing was conducted in conformance with the following ASTM Test Methods:

- "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass" (ASTM D2216);
- "Standard Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils" (ASTM D2974); and
- "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils" (ASTM D4318).

The unconfined compressive strengths were determined using a spring-loaded hand penetrometer. The hand penetrometer estimates the unconfined compressive strength to a maximum of 4-1/2 tons per square foot (tsf) by measuring the resistance of the soil sample to the penetration of a spring-loaded cylinder.

The results of the moisture contents, organic matter contents, and unconfined compressive strengths are indicated on the Soil Boring Logs, Figure Nos. 21 through 39, at the depths the samples were obtained. The results of the Atterberg Limits tests are presented graphically in the appendix as Figure No. 40.

We will hold the soil samples for 60 days from the date of this report, at which time they will be discarded. If you would like the samples, please let us know prior to this date.

SITE DESCRIPTION

Dexter High School

The Dexter High School campus is located at 2200 N. Parker Road in Dexter, Michigan. The existing school can be accessed via two access drives leading eastward into the parcel and via an access drive extending southward from Shield Road. The existing site grades are highest near the intersection of Shield and N. Parker Road and gently slope downward as you approach the existing school. The site grades immediately surrounding the existing building are at higher elevations at the northwest end of the building near the entrance of the school and lower toward to the southeast end of the building.

The existing school building is a single to four-story structure with one-story partially below grade at the north end. The campus also includes several soccer fields, two (2) baseball diamonds, ten (10) tennis courts, and a detention pond, as well as associated bituminous concrete service drives and parking areas, and Portland cement concrete (PCC) sidewalks. The remainder of the campus is covered in manicured lawn, includes several mature trees, and isolated areas of dense vegetation.

Existing surface grades throughout the campus range from Elevation 856 to 894 feet. Site grades near the proposed fieldhouse and adjacent parking lots range from Elevation 882 to 894 feet, generally sloping down from north to south or northwest to southeast. Site grades along the proposed service drive generally range from Elevation 893 to 865 feet, generally sloping down in an easterly direction.

Based on historical aerial imagery, the parcel appears to have been used for agricultural purposes prior to construction of the Dexter High School Campus leading up to 1998. Sometime between 1998 and 2005, the Dexter

High School building and northern athletic facilities were constructed. We observe the southwestern wooded area was cleared and twin turf fields were constructed sometime around 2020. We observed crack sealing has been performed throughout the bituminous concrete areas since the original construction of the campus.



Historical Aerial Imagery (1998)



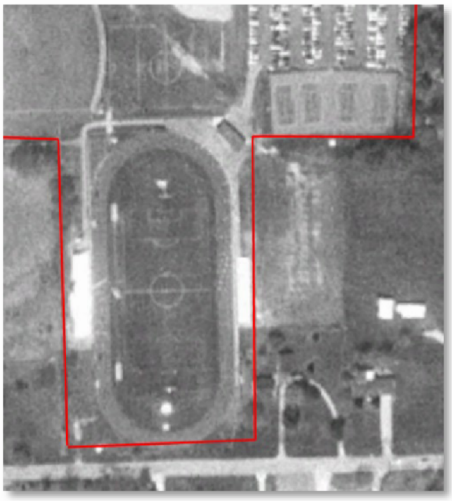
Historical Aerial Imagery (2005)



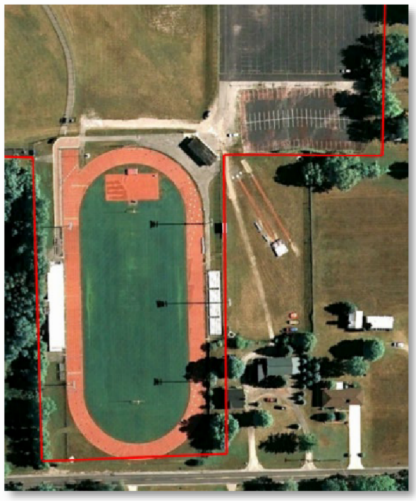
Aerial Imagery (2025)

Al Ritt Stadium

The Al Ritt Stadium is located at 2615 Baker Road in Dexter, Michigan. The stadium is located south of Creekside Intermediate School. The site appears to be relatively flat, sloping down slightly from east to west. The existing football field, running track, bleacher structures, and maintenance building appear to have been constructed sometime prior to 1993. Then, sometime around 2007, the athletic fields north of the football field were demolished and replaced with bituminous concrete parking areas. It appears that the restroom/concessions building located on the north side of the stadium was constructed sometime between 2007 and 2013.



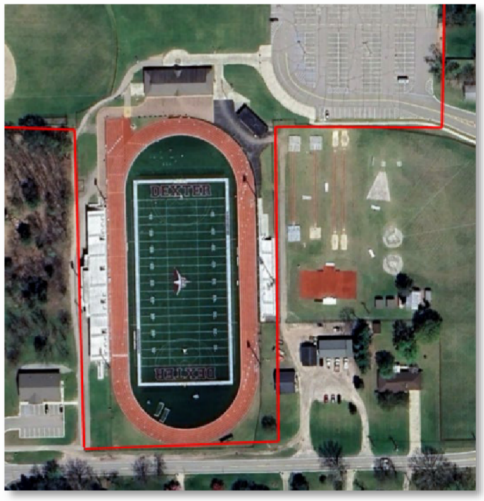
Historical Aerial Imagery (1993)



Historical Aerial Imagery (2007)



Historical Aerial Imagery (2013)



Aerial Imagery (2025)

SOIL CONDITIONS

DHS Fieldhouse Addition (B-21 through B-26 and D&A SB-1, SB-2, and SB-3)

Approximately 3 to 10 inches of topsoil is present at the ground surface of the soil borings. Within soil borings B-21 and B-22, clayey sand and silty clay fill soils underlie the topsoil and extend to an approximate depth of 3-1/2 feet. Alternating layers of native granular and cohesive soils consisting of sand, gravelly sand, silty sand, sandy silt, silty clay, sandy clay, and clayey silt, underlie the topsoil and fill soils and extend to the explored depth of 25 feet below existing grade.

The clayey sand fill is very loose in relative density with an SPT-N value of 2 blows per foot (bpf). The silty clay fill is very stiff in consistency with a moisture content of 19 percent and an unconfined compressive strength of 5,000 pounds per square foot (psf). The native cohesive soils within boring B-21 between 3-1/2 and 8-1/2 feet, within boring B-22 between 13-1/2 and 19-1/2 feet, within boring B-24 between 6 and 13-1/2 feet, and within B-25 between 18-1/2 and 24 feet are stiff in consistency with natural moisture contents between 10 and 21 percent and