



RENOVATIONS TO ALGER HALL

CYBER COMMAND CENTER

Rhode Island College



PROJECT MANUAL

Issued for Construction
August 30, 2024

Architect:
LLB Architects
161 Exchange Street,
Pawtucket, RI 02860

00 01 01 – TITLE PAGE

Owner:

State of Rhode Island Board of Education, Rhode Island College, and State of Rhode Island

User Agency:

Capital Projects Administration
Rhode Island College
600 Mount Pleasant Avenue
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Phone: (401) 456-9885

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LLB ARCHITECTS
AUGUST 30, 2024

RHODE ISLAND COLLEGE
RIC CYBER COMMAND CENTER – ALGER HALL
CONSTRUCTION DOCUMENTS

00 01 15 – LIST OF DRAWINGS

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LLB ARCHITECTS
AUGUST 30, 2024

RHODE ISLAND COLLEGE
RIC CYBER COMMAND CENTER – ALGER HALL
CONSTRUCTION DOCUMENTS

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Procurement documents are provided under separate cover.

END OF SECTION

LLB ARCHITECTS
AUGUST 30, 2024

RHODE ISLAND COLLEGE
RIC CYBER COMMAND CENTER – ALGER HALL
CONSTRUCTION DOCUMENTS

00 43 00 – BID BOND

See AIA Document A310-2010, attached as the following page.

END OF SECTION

Bid Bond

CONTRACTOR:
(Name, legal status and address)

<< >>< >>
<< >>

SURETY:
(Name, legal status and principal place of business)

<< >>< >>
<< >>

OWNER:
(Name, legal status and address)

<< >>< >>
<< >>

BOND AMOUNT: \$ << >>

PROJECT:
(Name, location or address, and Project number, if any)

<< >>
<< >>
<< >>

The Contractor and Surety are bound to the Owner in the amount set forth above, for the payment of which the Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, as provided herein. The conditions of this Bond are such that if the Owner accepts the bid of the Contractor within the time specified in the bid documents, or within such time period as may be agreed to by the Owner and Contractor, and the Contractor either (1) enters into a contract with the Owner in accordance with the terms of such bid, and gives such bond or bonds as may be specified in the bidding or Contract Documents, with a surety admitted in the jurisdiction of the Project and otherwise acceptable to the Owner, for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof; or (2) pays to the Owner the difference, not to exceed the amount of this Bond, between the amount specified in said bid and such larger amount for which the Owner may in good faith contract with another party to perform the work covered by said bid, then this obligation shall be null and void, otherwise to remain in full force and effect. The Surety hereby waives any notice of an agreement between the Owner and Contractor to extend the time in which the Owner may accept the bid. Waiver of notice by the Surety shall not apply to any extension exceeding sixty (60) days in the aggregate beyond the time for acceptance of bids specified in the bid documents, and the Owner and Contractor shall obtain the Surety's consent for an extension beyond sixty (60) days.

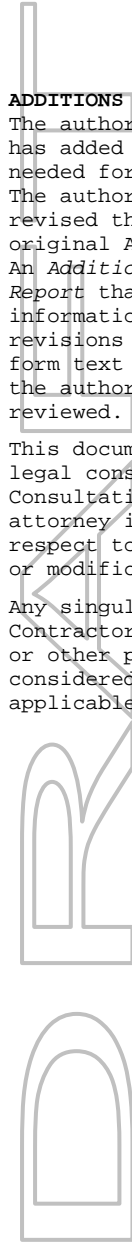
If this Bond is issued in connection with a subcontractor's bid to a Contractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Project, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.



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Signed and sealed this « » day of « », « »

(Witness)

(Witness)

« »

(Contractor as Principal)

(Seal)

« »

(Title)

« »

(Surety)

(Seal)

« »

(Title)





AIA[®] Document A101[™] – 2017

Standard Form of Agreement Between Owner and Contractor where the basis of payment is a Stipulated Sum

AGREEMENT made as of the day of in the year
(In words, indicate day, month and year.)

BETWEEN the Owner:
(Name, legal status, address, telephone and facsimile numbers, and website)

**State of Rhode Island, acting by and through the Department of Administration,
Division of Purchases, on behalf of the User AgencyOne Capitol Hill, Second Floor
Providence, Rhode Island 02908-5855
401.578.8100 (telephone); 401.574.8387 (facsimile)
www.puchasing.ri.gov**

on behalf of the User Agency:
(Name, legal status, address, telephone and facsimile numbers, and website)

Rhode Island College
600 Mt Pleasant Ave
Providence, RI 02908
Tel: (401) 456-9885
www.ric.edu

and the Contractor:
(Name, legal status, address, telephone and facsimile numbers, and website)

for the following Project:
(Name, location and detailed description)

The Design Agent:
(Name, legal status, address, telephone and facsimile numbers, and website)

The Owner and Contractor agree as follows.

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

The parties should complete A101[™]-2017, Exhibit A, Insurance and Bonds, contemporaneously with this Agreement. AIA Document A201[™]-2017, General Conditions of the Contract for Construction, is adopted in this document by reference. Do not use with other general conditions unless this document is modified.

Init.

Phase Liquidated Damages Sum

.3 The Owner and the Contractor have reasonably determined the sums set forth in this Section 4.5 to be a fair estimate of the Owner' actual damages which are difficult to ascertain in the event of delay.

§ 4.6 Other:
(Paragraph Deleted)

The Owner shall not be liable to the Contractor or any Subcontractor for claims or damages of any nature caused by or arising out of any delays. The sole remedy against the Owner for delays shall be the allowance of additional time for completion of the Work.

ARTICLE 5 PAYMENTS

§ 5.1 Progress Payments

§ 5.1.1 Based upon Applications for Payment submitted to the Design Agent by the Contractor and Certificates for Payment issued by the Design Agent and approved by the Owner in writing, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

§ 5.1.2 The period covered by each Application for Payment shall be one calendar month ending on the last day of the month.

§ 5.1.3 The Owner shall make payment of the certified amount, less retainage, to the Contractor not later than the 30th working day following written approval by the Owner.

(Paragraph Deleted)

§ 5.1.4 Each Application for Payment shall be based on the most recent schedule of values submitted by the Contractor and approved by the Design Agent and the Owner in accordance with the Contract Documents. The schedule of values shall allocate the entire Contract Sum among the various portions of the Work. The schedule of values shall be prepared in such form, and supported by such data to substantiate its accuracy, as the Design Agent and the Owner may require. This schedule of values shall be used as a basis for reviewing the Contractor's Applications for Payment.

§ 5.1.5 Applications for Payment shall show the percentage of completion of each portion of the Work as of the end of the period covered by the Application for Payment.

§ 5.1.6 In accordance with AIA Document A201™-2007, General Conditions of the Contract for Construction as modified by the Owner, and subject to other provisions of the Contract Documents, the amount of each progress payment shall be computed as follows:

§ 5.1.6.1 The amount of each progress payment shall first include:

- .1 That portion of the Contract Sum properly allocable to completed Work;
- .2 That portion of the Contract Sum properly allocable to materials and equipment delivered and suitably stored at the site for subsequent incorporation in the completed construction, or, if approved in advance by the Owner, suitably stored off the site at a location agreed upon in writing; and
- .3 That portion of Construction Change Directives that the Design Agent determines, in the Design Agent's professional judgment, to be reasonably justified.

§ 5.1.6.2 The amount of each progress payment shall then be reduced by:

- .1 The aggregate of any amounts previously paid by the Owner;
- .2 The amount, if any, for Work that remains uncorrected and for which the Design Agent has previously withheld a Certificate for Payment as provided in Article 9 of AIA Document

A201-2007 as modified by the Owner;

- .3 For Work performed or defects discovered since the last payment application, any amount for which the Design Agent may withhold payment, or nullify a Certificate of Payment in whole or in part, as provided in Article 9 of AIA Document A201-2007 as modified by the Owner; and
- .4 Retainage withheld pursuant to Section 5.1.7.

§ 5.1.7 Retainage

§ 5.1.7.1 For each progress payment made prior to Substantial Completion of the Work, the Owner may withhold the following amount, as retainage, from the payment otherwise due: five (5%) percent.

(Paragraph Deleted)

§ 5.1.7.1.1 Deleted.

(Paragraph Deleted)

§ 5.1.7.2 Deleted.

(Paragraph Deleted)

§ 5.1.7.3 Except as set forth in this Section 5.1.7.3, upon Substantial Completion of the Work, the Contractor may submit an Application for Payment that includes the retainage withheld from prior Applications for Payment pursuant to this Section 5.1.7. The Application for Payment submitted at Substantial Completion shall not include retainage as follows:

(Paragraph Deleted)

The amount of five (5%) percent shall be retained by the Owner through the date of Substantial Completion of the Work and then after the date of Substantial Completion of the Work in accordance with R.I. Gen. Laws § 37-12-10.1.

§ 5.1.8 If final completion of the Work is materially delayed through no fault of the Contractor, the Owner shall pay the Contractor any additional amounts in accordance with Article 9 of AIA Document A201-2007 as modified by the Owner.

§ 5.1.9 Except with the Owner's prior written approval, the Contractor shall not make advance payments to suppliers for materials or equipment which have not been delivered and stored at the site.

§ 5.1.10 Within 10 working days of receipt of any progress payment from the Owner, the Contractor must pay its Subcontractors the full amount included for each such Subcontractor within the Contractor's Application for Payment in accordance with the provisions of AIA A201 - 2007, General Conditions of the Contract for Construction as modified by the Owner.

§ 5.2 Final Payment

§ 5.2.1 Final payment, constituting the entire unpaid balance of the Contract Sum, less the amount withheld pursuant to § 5.1.7.3, shall be made by the Owner to the Contractor when:

- .1 the Contractor has fully performed the Contract except for the Contractor's responsibility to correct Work as provided in Article 12 of AIA Document A201-2007 as modified by the Owner, and to satisfy other requirements, if any, which extend beyond final payment; and
- .2 a final Certificate for Payment has been issued by the Design Agent and approved in writing by the Owner;
- .3 the Contractor has submitted its final release and final releases from all of its Subcontractors and suppliers in a form acceptable to the Owner; and
- .4 the Contractor has submitted to the Owner all close-out documents, including without limitation, all as-built plans, warranties, manuals, and other materials set forth in the Contract Documents.

Init.

§ 5.2.2 The Owner's final payment to the Contractor shall be made no later than 30 working days after the issuance of the Design Agent's final Certificate for Payment and written approval by the Owner.

§ 5.3 Interest

Payments due and unpaid under the Contract shall bear interest from the date payment is due in accordance with the provisions of "Prompt Payment by Department of Administration," R.I. Gen. Laws §§ 42-11.1-1 **et seq.**

§ 5.4 Owner's Rights

§ 5.4.1 The Owner shall have the right to deduct from any payments due to the Contractor the amount of any unpaid obligations owed to the State of Rhode Island by the Contractor, including without limitation, any and all unpaid taxes, the amount of any claim against the Contractor arising out of this Agreement, or any amount on account of any other reason permitted by applicable law.

§ 5.5 Pursuant to R.I. Gen. Laws § 44-1-6, the Owner shall withhold payment from the Contractor if the Contractor does not maintain a regular place of business in Rhode Island in the amount of three (3%) percent of the Contract Sum until 30 calendar days after Final Completion and compliance by the Contractor with the requirements of such section. The three (3%) percent withheld pursuant to R.I. Gen. Laws § 44-1-6 is not considered retainage which is held pursuant to § 5.1.7.

(Paragraph Deleted)

ARTICLE 6 DISPUTE RESOLUTION

§ 6.1 Initial Decision Maker

Claims shall be referred to the Initial Decision Maker for initial decision. The Purchasing Agent appointed pursuant to the provisions of the "State Purchases Act," R.I. Gen. Laws § 37-2-1 **et seq.**, will serve as the Initial Decision Maker in accordance with the provisions of the State Purchases Act, State of Rhode Island Procurement Regulations, and this Section 6.1. An initial decision shall be required as a condition precedent to binding dispute resolution pursuant to Section 6.3 of any Claim arising prior to the date final payment is due.

§ 6.2 Mediation

For any Claim not resolved by the Initial Decision Maker procedures set forth in Section 6.1, and prior to the implementation of the binding dispute resolution procedures set forth in Section 6.3, the Contractor shall have the option to pursue mediation, exercisable by written notice to the Owner within 30 calendar days of an Initial Decision. In the event of the exercise of such option by the Contractor, the Owner and the Contractor shall attempt to select a mediator, and in the event that the Owner and the Contractor cannot agree on a mediator, either party may apply in writing to the Presiding Justice of the Providence County Superior Court, with a copy to the other, with a request for the court to appoint a mediator, and the costs of the mediator shall be borne equally by both parties.

(Paragraph Deleted)

§ 6.3 Binding Dispute Resolution

For any Claim not resolved by the Initial Decision Maker procedures set forth in Section 6.1, or mediation at the option of the Contractor pursuant to Section 6.2, the method of binding dispute resolution shall be determined in accordance with the provisions of the "Public Works Arbitration Act," R.I. Gen. Laws §§ 37-16-1 **et seq.**

ARTICLE 7 TERMINATION OR SUSPENSION

§ 7.1 The Contract may be terminated by the Owner or the Contractor as provided in Article 14 of AIA Document A201-2007, as modified by the Owner. The Contract may also be terminated by the Owner: (i) in the event of the unavailability of appropriated funds; (ii) in the absence of a determination of continued need; or (iii) as otherwise provided in the State of Rhode Island Procurement Regulations General Conditions of Purchase or other applicable law.

§ 7.1.1 Deleted.

§ 7.2 The Work may be suspended by the Owner as provided in: (i) the State of Rhode Island General Conditions of Purchase Regulation or other applicable law; or (ii) Article 14 of AIA Document A201–2007 as modified by the Owner.

ARTICLE 8 MISCELLANEOUS PROVISIONS

§ 8.1 Where reference is made in this Agreement to a provision of AIA Document A201–2007 or another Contract Document, the reference refers to: (i) the AIA Document A201 – 2007 or other Contract Document as modified by the Owner; and (ii) that provision in the AIA Document A201 – 2007 as modified by the Owner or other Contract Document as amended or supplemented by other provisions of the Contract Documents.

§ 8.2 Representatives for the Owner

§ 8.2.1 The Owner's representative:

(Name, title, address, email address, and other information for the preferred methods of contact)

§ 8.2.2 The User Agency's representative:

(Name, title, address, email address, and other information for the preferred methods of contact)

Kevin Fitta, P.E., Director Capital Projects
Rhode Island College
600 Mt Pleasant Ave
Providence, RI 02908
Tel: (401) 456-9885
Email: kfitta@ric.edu

§ 8.2.3 The Design Agent's representative:

(Name, title, address, email address, and other information for the preferred methods of contact)

§ 8.3 The Contractor's representative:

(Name, title, address, email address, and other information for the preferred methods of contact)

§ 8.4 Neither the Owner's nor the Contractor's representative nor the Design Agent's representative shall be changed without 10 working days' prior notice to the other party.

§ 8.5 Insurance and Bonds

§ 8.5.1 The Owner and the Contractor shall purchase and maintain insurance as set forth in the Solicitation and elsewhere in the Contract Documents.

§ 8.5.2 The Contractor shall provide bonds as set forth in the Solicitation and elsewhere in the Contract Documents.

§ 8.6 Deleted.

Init.

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User Notes:

(3B9ADA4B)

§ 8.7 Other provisions:

§ 8.7.1 The Contractor represents and warrants to the Owner, in addition to any other representations and warranties of the Contractor elsewhere in the Contract Documents:

.1 The Contractor and its Subcontractors are each financially solvent, able to pay their debts as they mature, and possess sufficient working capital to perform their obligations under the Contract Documents.

.2 The Contractor and its Subcontractors are each able to furnish the tools, materials, equipment, and labor required to complete the Project as required under the Contract Documents.

.3 *The Contractor and each Subcontractor are authorized to do business in the State of Rhode Island and are properly licensed by all necessary governmental authorities having jurisdiction over them and over the Work and the Project.*

.4 The execution of this Agreement and its performance is within its duly authorized powers.

.5 The Contractor has visited the site of the Project, familiarized itself with the local and special conditions under which the Work is to be performed, and correlated its observations with the requirements of the Contract Documents.

.6 The Contractor possesses the requisite level of experience and expertise in the business administration, construction, and superintendence of projects of the size, complexity, and nature of the Project, and it will perform the Work with the care, skill, and diligence of a contractor possessing such experience and expertise.

§ 8.7.2 The representations and warranties of the Contractor in this Section 8.7 and elsewhere in the Contract Documents will survive the execution and delivery of this Agreement, any termination of this Agreement, and the final completion of the Work.

§ 8.7.3 Any Change Orders or other Modifications must be approved in writing by the Owner.

§ 8.7.4 The Owner is the State of Rhode Island, acting by and through its Department of Administration, Division of Purchases, and therefore, pursuant to the provisions of R.I. Gen. Laws § 34-28-31, mechanics liens may not be placed against the Project.

ARTICLE 9 ENUMERATION OF CONTRACT DOCUMENTS

§ 9.1 This Agreement is comprised of the following documents:

- .1 AIA Document A101™–2017, Standard Form of Agreement Between Owner and Contractor, as modified by the Owner
- .2 Deleted.
- .3 AIA Document A201™–2007, General Conditions of the Contract for Construction, as modified by the Owner.
- .4 Deleted.
- .5 Drawings

(Table Deleted)

The Drawings are included in the Solicitation and are available on the Division of Purchases website at www.purchasing.ri.gov.

- .6 Specifications

(Table Deleted)

The Specifications are included in the Solicitation and are available on the Division of Purchases website at www.purchasing.ri.gov.

- .7 Addenda, if

(Table Deleted)

any, issued pursuant to the Solicitation form a part of the Solicitation and are available on the Division of Purchases website at www.purchasing.ri.gov.

.8

Supplementary and other Conditions of the Contract, including without limitation, the State of Rhode Island General Conditions of Purchase Regulation.

.9 Other documents listed below:

(Paragraph Deleted)

.1 The Solicitation, issued by the Owner, including without limitation, the Invitation to Bid, the Instructions to Bidders, the Specifications and Drawings, any Addenda, and the Bid Checklist.

(Paragraph Deleted)

.2 The Bid Proposal, including without limitation, the Bid Form and the Bidder Certification Cover Form.

(Table Deleted)

.3 The Purchase Order issued by the Owner.

§ 9.2 This Agreement and the Contract Documents are subject to, and governed by, the laws of the State of Rhode Island, including all procurement statutes and regulations (available at www.purchasing.ri.gov), and applicable federal and local law, all of which are fully incorporated into this Agreement by this reference.

(Table Deleted)

(Paragraph Deleted)

§ 9.3 *In the event of any conflict between or among the Contract Documents, or any Contract Documents and any provision of the State of Rhode Island Procurement Regulations and/or any other provision of the Rhode Island General Laws, the State of Rhode Island Procurement Regulations and the Rhode Island General Laws shall control.*

ARTICLE 10 BENEFITS OF AGREEMENT

§ 10.1 The User Agency is a disclosed third-party beneficiary of this Agreement and shall have all of the rights and benefits hereunder to which such a party is entitled. Nothing contained in this Agreement shall create a contractual relationship with, or a cause of action in favor of, any other third party against the Owner or the User Agency.

§ 10.2 This Agreement shall be binding on the Contractor and its successors and assigns; provided, however, that the Contractor may not assign its rights nor delegate its responsibilities under this Agreement without the Owner's prior written consent.

This Agreement is entered into as of the day and year first written above; provided, however, that this Agreement shall not become a valid, binding, and enforceable contract unless and until the Owner shall have issued a Purchase Order.

Init.

AIA[®] Document A201[™] – 2007

General Conditions of the Contract for Construction

for the following PROJECT:
(Name and location or address)

THE OWNER:
(Name, legal status and address)

(Paragraphs deleted) The State of Rhode Island, acting by and through the Department of Administration Division of Purchases, on behalf of the User Agency

One Capitol Hill, Second Floor
Providence, Rhode Island 02908-5855
(401) 574-8100 (telephone)
(401) 574-8387 (facsimile)

(Paragraph deleted)

www.purchasing.ri.gov

THE USER AGENCY

(Paragraphs deleted)
(Name, address, telephone and facsimile numbers, and web address)

Rhode Island College
600 Mt Pleasant Ave
Providence, RI 02908
Tel: (401) 456-9885

(Paragraph deleted)

www.ric.edu

(Paragraphs deleted)

(Paragraphs deleted)

THE Design Agent:

(Name, legal status, address, telephone and facsimile numbers, and web address)

ADDITIONS AND DELETIONS:

The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

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Init.

ARTICLE 1 GENERAL PROVISIONS

§ 1.1 BASIC DEFINITIONS

§ 1.1.1 THE CONTRACT DOCUMENTS

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (the Agreement) and consist of the Agreement (and the documents enumerated therein), Conditions of the Contract (General Conditions, Supplementary Conditions, if any, and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive or (4) a written order for a minor change in the Work issued by the Design Agent.

§ 1.1.2 THE CONTRACT

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Design Agent or the Design Agent's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Design Agent or the Design Agent's consultants or (4) between any persons or entities other than the Owner and the Contractor. The Design Agent shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Design Agent's duties.

§ 1.1.3 THE WORK

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 THE PROJECT

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by separate contractors.

§ 1.1.5 THE DRAWINGS

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location, and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 THE SPECIFICATIONS

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 INSTRUMENTS OF SERVICE

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Design Agent and the Design Agent's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 INITIAL DECISION MAKER

The Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2 and certify termination of the Agreement under Section 14.2.2.

§ 1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

§ 1.2.1 The intent of the Contract Documents is to include all items and services necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; the Contractor shall perform all work reasonably inferable from the Contract Documents as being necessary to produce the indicated results.

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

Init.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.2.4 In the event of any conflicts or discrepancies among the Contract Documents, the provisions of the Contract Documents will be interpreted in the following order of priority:

- .1 Modifications (if any).
- .2 The Purchase Order.
- .3 The Agreement.
- .4 The Solicitation, including any Addenda, and the Specifications and Drawings
- .5 The Supplementary Conditions (if any).
- .6 The General Conditions.
- .7 The Bid Proposal.

§ 1.2.5 In the event of any conflicts or discrepancies between the Contract Documents and the State of Rhode Island Procurement Regulations or any provision of the Rhode Island General Laws, the State of Rhode Island Procurement Regulations and the Rhode Island General Laws will control.

§ 1.2.6 In the event of any inconsistency between the Drawings and Specifications, the better quality or greater quantity of Work shall be provided.

§ 1.2.7 The Owner will be the final decision maker for any and all interpretations.

§ 1.3 CAPITALIZATION

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 INTERPRETATION

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 OWNERSHIP AND USE OF DRAWINGS, SPECIFICATIONS AND OTHER INSTRUMENTS OF SERVICE

§ 1.5.1 The Owner and the User Agency shall have a perpetual license to utilize the Drawings, Specifications, and other documents, including electronic or digital documents, prepared by the Design Agent and the Design Agent's consultants, for the execution of the Project and shall have and retain all rights to use them and reproduce them for the production and maintenance of the Work described therein. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with this Project is not to be construed as publication in derogation of the Design Agent's or Design Agent's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors and material or equipment suppliers are authorized to use and reproduce the Instruments of Service provided to them solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers may not use the Instruments of Service on other projects or for additions to this Project outside the scope of the Work without the specific written consent of the Owner, Design Agent and the Design Agent's consultants.

§ 1.6 TRANSMISSION OF DATA IN DIGITAL FORM

If the parties intend to transmit Instruments of Service or any other information or documentation in digital form, they shall endeavor to establish necessary protocols governing such transmissions, unless otherwise already provided in the Agreement or the Contract Documents.

ARTICLE 2 OWNER

§ 2.1 GENERAL

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express

authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Design Agent does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 Deleted.

§ 2.2 INFORMATION AND SERVICES REQUIRED OF THE OWNER

§ 2.2.1 Deleted.

§ 2.2.2 The Contractor shall secure and pay for permits and fees, necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.2.3 If required for the Work in the discretion of the Owner, the Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of any information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

§ 2.2.4 The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.2.5 Deleted.

§ 2.3 OWNER'S RIGHT TO STOP THE WORK

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

§ 2.4 OWNER'S RIGHT TO CARRY OUT THE WORK

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a 10 working-day period after receipt of written notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such deficiencies. In such case an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Design Agent's additional services made necessary by such default, neglect, or failure. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Design Agent. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

ARTICLE 3 CONTRACTOR

§ 3.1 GENERAL

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Design Agent, or by tests, inspections, or approvals required or performed by persons or entities other than the Contractor.

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§ 3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed and correlated personal observations with requirements of the Contract Documents.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.2.3, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Owner and the Design Agent any errors, inconsistencies, or omissions discovered by or made known to the Contractor or additional Drawings, Specifications, or instructions required to define the Work in greater detail to permit the proper progress of the Work as a request for information in such form as the Design Agent may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ 3.2.3 The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Design Agent and the Owner any nonconformity discovered by or made known to the Contractor as a request for information in such form as the Design Agent or Owner may require.

§ 3.2.3.1 Omissions from the Drawings and Specifications of items obviously needed to perform the Work properly, such as attachments, bolts, hangers, and other fastening devices, shall not relieve the Contractor from the obligation to furnish and install such items.

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Design Agent issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall make Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2, 3.2.3, or 3.2.3.1, the Contractor shall pay such costs and damages to the Owner as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Design Agent for damages resulting from errors, inconsistencies, or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities.

§ 3.2.4.1 The Contractor shall not make any changes without prior written authorization from the Design Agent and the Owner.

§ 3.2.5 The Owner is entitled to reimbursement from the Contractor for amounts paid to the Design Agent for evaluating and responding to the Contractor's requests for information that are not prepared in accordance with the Contract Documents or where the requested information is available to the Contractor from a careful study and comparison of the Contract Documents, field conditions, other Owner-provided information, Contractor-prepared coordination drawings, or prior Project correspondence or documentation.

§ 3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

§ 3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless the Contract Documents give other specific instructions concerning these matters. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences or procedures, the Contractor shall evaluate the jobsite safety thereof and, except as stated below, shall be fully and solely responsible for the jobsite safety of such means, methods, techniques, sequences or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely written notice to the Owner and Design Agent and shall not proceed with that portion of the Work without further written instructions from the Design Agent. If the Contractor is then instructed to proceed with the required means, methods, techniques, sequences or procedures without

acceptance of changes proposed by the Contractor, the Owner shall be solely responsible for any loss or damage arising solely from those Owner-required means, methods, techniques, sequences or procedures.

§ 3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.4 LABOR AND MATERIALS

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work. Whenever the Contractor has an obligation to provide labor and materials under the Agreement, the Contractor, at a minimum, shall provide the labor for, and furnish and install and place in operation all items, including without limitation, all proper connections.

§ 3.4.2 Except in the case of minor changes in the Work authorized by the Design Agent in accordance with Sections 3.12.8 or 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Design Agent and in accordance with a Change Order or Construction Change Directive.

§ 3.4.3 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

§ 3.5 WARRANTY

The Contractor warrants to the Owner and the Design Agent that materials and equipment furnished under the Contract will be of first quality, prime manufacture, and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements, including substitutions not properly authorized, may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Design Agent, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.6 TAXES

§ 3.6.1 The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

§ 3.6.2 The State of Rhode Island is exempt from payment of any federal or state excise, transportation, or sales tax. The Rhode Island Department of Administration Division of Purchases will furnish Exemption Certificates upon request.

§ 3.7 PERMITS, FEES, NOTICES AND COMPLIANCE WITH LAWS

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections required by the Rhode Island State Building Code necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded. The Contractor shall be responsible for obtaining the Certificate of Occupancy from the appropriate governmental authorities.

§ 3.7.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

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§ 3.7.3 The Contractor shall promptly notify the Design Agent and the Owner if the Contractor becomes aware that the Contract Documents are not in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities. If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions. If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature, that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Design Agent before conditions are disturbed and in no event later than 21 working days after first observance of the conditions. The Design Agent will promptly investigate such conditions and, if the Design Agent determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend an equitable adjustment in the Contract Sum or Contract Time, or both. If the Design Agent determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Design Agent shall promptly notify the Owner and Contractor in writing, stating the reasons. If either party disputes the Design Agent's determination or recommendation, that party may proceed as provided in Article 15.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Design Agent. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

§ 3.8 ALLOWANCES

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

- .1 Allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- .2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and
- .3 Whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 SUPERINTENDENT

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner through the Design Agent the name and qualifications of a proposed superintendent. The Design Agent may reply within 14 working days to the Contractor in writing stating (1) whether the Owner or the Design Agent has reasonable objection to the proposed superintendent or (2) that the Design Agent requires additional time to review. Failure of the Design Agent to reply within the 14 working-day period shall constitute notice of no reasonable objection.

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Design Agent has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

§ 3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES

§ 3.10.1 The Contractor, within 20 working days after the issuance of the Purchase Order, shall prepare and submit for the Owner's and Design Agent's information a Contractor's construction schedule for the Work. The schedule shall not exceed time limits current under the Contract Documents, shall be revised at appropriate intervals, not less frequently than monthly, as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for expeditious and practicable execution of the Work. The Contractor shall certify on the initial schedule and all revised schedules that they comply with the Contract Documents.

§ 3.10.2 The Contractor shall prepare a submittal schedule, within 20 working days after the issuance of the Purchase Order, and thereafter as necessary to maintain a current submittal schedule, and shall submit the schedule(s) for the Owner's and the Design Agent's approval. The Owner's and the Design Agent's approval shall not unreasonably be delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Owner and the Design Agent reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Design Agent.

§ 3.11 DOCUMENTS AND SAMPLES AT THE SITE

The Contractor shall maintain at the site for the Owner one copy of the Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and one copy of approved Shop Drawings, Product Data, Samples and similar required submittals. These shall be available to the Design Agent and shall be delivered to the Design Agent for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ 3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

§ 3.12.3 Samples are physical examples that illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. Their purpose is to demonstrate the way by which the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Design Agent is subject to the limitations of Section 4.2.7. Informational submittals upon which the Design Agent is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Design Agent without action.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve and submit to the Design Agent Shop Drawings, Product Data, Samples and similar submittals required by the Contract Documents in accordance with the submittal schedule approved by the Owner and the Design Agent or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate contractors.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents to the Owner and Design Agent that the Contractor has (1) reviewed and approved them, (2) determined and verified

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materials, field measurements and field construction criteria related thereto, or will do so and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal has been approved by the Design Agent.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Design Agent's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Design Agent in writing of such deviation at the time of submittal and (1) the Design Agent has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Design Agent's approval thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by the Design Agent on previous submittals. In the absence of such written notice, the Design Agent's approval of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. The Contractor shall not be required to provide professional services in violation of applicable law. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Design Agent will specify all performance and design criteria that such services must satisfy. The Contractor shall cause such services or certifications to be provided by a properly licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Design Agent. The Owner and the Design Agent shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Design Agent have specified to the Contractor all performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Design Agent will review, approve, or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Contractor shall not be responsible for the adequacy of the performance and design criteria specified in the Contract Documents.

§ 3.12.11 The Owner shall be entitled to reimbursement from the Contractor for amounts paid to the Design Agent for evaluation of resubmittals.

§ 3.13 USE OF SITE

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, and any restrictions imposed by the User Agency or the Owner, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

§ 3.14 CUTTING AND PATCHING

§ 3.14.1 The Contractor shall be responsible for cutting, fitting or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting and patching shall be restored to the condition existing prior to the cutting, fitting and patching, unless otherwise required by the Contract Documents.

§ 3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably

withheld. The Contractor shall not unreasonably withhold from the Owner or a separate contractor the Contractor's consent to cutting or otherwise altering the Work.

§ 3.15 CLEANING UP

§ 3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery and surplus materials from and about the Project.

§ 3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and Owner shall be entitled to reimbursement from the Contractor.

§ 3.16 ACCESS TO WORK

The Contractor shall provide the Owner and Design Agent access to the Work in preparation and progress wherever located.

§ 3.17 ROYALTIES, PATENTS AND COPYRIGHTS

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Design Agent harmless from loss on account thereof, but shall not be responsible for such defense or loss when a particular design, process or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications or other documents prepared by the Owner or Design Agent. However, if the Contractor has reason to believe that the required design, process or product is an infringement of a copyright or a patent, the Contractor shall be responsible for such loss unless such information is promptly furnished to the Design Agent and the Owner.

§ 3.18 INDEMNIFICATION

§ 3.18.1 To the fullest extent permitted by law the Contractor shall indemnify and hold harmless the Owner, the State of Rhode Island, and each executive, legislative, judicial, regulatory, and administrative body of the state, and any political subdivision thereof, including without limitation, any department, division, agency, commission, board, office, bureau, committee, authority, educational institution, school, water, and fire district, and other agency of Rhode Island state, municipal, and local government that exercises governmental functions, any other governmental authority, and any quasi-public corporation and/or body corporate and politic, including without limitation, the User Agency, their elected and appointed officials, members, employees, and agents, the Design Agent, the Design Agent's Consultants, Subconsultants, and Subcontractors, and agents and employees and any of them from and against any and all claims, demands, damages, liabilities, judgments, losses and expenses, including but not limited to attorneys' fees and costs of mediation, arbitration, and/or litigation, arising out of or resulting from performance of the Work, and/or the obligations of the under the Contract Documents, but only to the extent caused by the acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not any such claim, demand, damage, liability, judgment, loss or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts or other employee benefit acts.

§ 3.18.3 Without limiting the generality of the foregoing, the defense and indemnity set forth in this Section 3.18 includes, without limitation, all liabilities, damages, losses, claims, demands, and actions on account of bodily injury, death, or property loss to a person or entity indemnified hereunder or any other persons or entities, whether based upon statutory (including, without limitation, workers compensation), contractual, tort, or other liability of any person or entity so indemnified.

§ 3.18.4 The remedies set forth herein shall not deprive any person indemnified hereunder of any other indemnity action, right, or remedy otherwise available to any such person or entity at common law or otherwise.

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§ 3.18.5 The Contractor will include the indemnity set forth in this Section 3.18, without modification, in each Subcontract with any Subcontractor.

§ 3.18.6 Notwithstanding any other language in the Contract Documents to the contrary, the indemnity hereunder shall survive Final Completion of the Work and final payment under the Agreement and shall survive any termination of the Agreement.

ARTICLE 4 DESIGN AGENT

§ 4.1 GENERAL

§ 4.1.1 The Design Agent is the person lawfully licensed to practice his or her profession in the State of Rhode Island or an entity lawfully practicing its profession in the State of Rhode Island and identified in the Contract Documents as the Design Agent. The term "Design Agent" means the Design Agent or the Design Agent's authorized representative.

§ 4.1.2 Duties, responsibilities and limitations of authority of the Design Agent as set forth in the Contract Documents shall not be restricted, modified or extended without written consent of the Owner, Contractor and Design Agent. Consent shall not be unreasonably withheld.

§ 4.1.3 If the employment of the Design Agent is terminated, the Owner shall employ a successor Design Agent as to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Design Agent.

§ 4.2 ADMINISTRATION OF THE CONTRACT

§ 4.2.1 The Owner with assistance from the Design Agent will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction through the date the Design Agent issues the final Certificate for Payment and continuing until the expiration of the one-year period following Final Completion. The Design Agent will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ 4.2.2 The Design Agent will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Design Agent will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Design Agent will not have control over, charge of, or responsibility for, the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents, except as provided in Section 3.3.1.

§ 4.2.2.1 The Owner is entitled to reimbursement from the Contractor for amounts paid to the Design Agent for site visits made necessary by the fault of the Contractor or by defects and deficiencies in the Work.

§ 4.2.3 On the basis of the site visits, the Design Agent will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and report to the Owner (1) known deviations from the Contract Documents and from the most recent construction schedule submitted by the Contractor, and (2) defects and deficiencies observed in the Work. The Design Agent will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Design Agent will not have control over or charge of and will not be responsible for acts or omissions of the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.2.4 COMMUNICATIONS FACILITATING CONTRACT ADMINISTRATION

Except as otherwise provided in the Contract Documents or when direct communications have been specially authorized, the Owner and Contractor shall endeavor to communicate with each other through the Design Agent about matters arising out of or relating to the Contract. Communications by and with the Design Agent's consultants shall be through the Design Agent. Communications by and with Subcontractors and material suppliers shall be through the Contractor. Communications by and with separate contractors shall be through the Owner.

§ 4.2.5 Based on the Design Agent's evaluations of the Contractor's Applications for Payment, the Design Agent will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ 4.2.6 The Design Agent has authority to reject Work that does not conform to the Contract Documents. Whenever the Design Agent considers it necessary or advisable, the Design Agent will have authority to require inspection or testing of the Work in accordance with Sections 13.5.2 and 13.5.3, whether or not such Work is fabricated, installed or completed. However, neither this authority of the Design Agent nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Design Agent to the Contractor, Subcontractors, material and equipment suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ 4.2.7 The Design Agent will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Design Agent's action will be taken in accordance with the submittal schedule approved by the Design Agent or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Design Agent's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Design Agent's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5 and 3.12. The Design Agent's review shall not constitute approval of safety precautions or, unless otherwise specifically stated by the Design Agent, of any construction means, methods, techniques, sequences or procedures. The Design Agent's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

§ 4.2.8 The Design Agent will prepare Change Orders and Construction Change Directives, and may authorize minor changes in the Work as provided in Section 7.4. The Design Agent will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Design Agent will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ 4.2.10 If the Owner and Design Agent agree, the Design Agent will provide one or more project representatives to assist in carrying out the Design Agent's responsibilities at the site. The duties, responsibilities and limitations of authority of such project representatives shall be as set forth in an exhibit to be incorporated in the Contract Documents.

§ 4.2.11 The Design Agent will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Design Agent's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ 4.2.12 Interpretations and decisions of the Design Agent will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations and decisions, the Design Agent will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either and will not be liable for results of interpretations or decisions rendered in good faith.

§ 4.2.13 The Design Agent's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents and approved by the Owner.

§ 4.2.14 The Design Agent will review and respond to requests for information about the Contract Documents. The Design Agent's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Design Agent will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

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ARTICLE 5 SUBCONTRACTORS

§ 5.1 DEFINITIONS

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a separate contractor or subcontractors of a separate contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ 5.2 AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK

§ 5.2.1 Unless otherwise stated in the Contract Documents or the bidding requirements, the Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner and the Design Agent the names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each portion of the Work. The Owner may reply within 14 working days to the Contractor in writing stating (1) whether the Owner or the Design Agent has reasonable objection to any such proposed person or entity or (2) that the Owner or Design Agent requires additional time for review.

§ 5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Design Agent has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.3 If the Owner or Design Agent has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Design Agent has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person or entity previously selected if the Owner or Design Agent makes reasonable objection to such substitution.

§ 5.2.5 MANUFACTURERS AND FABRICATORS

§ 5.2.5.1 Not later than 10 working days after the date of commencement of the Work, the Contractor shall furnish in writing to the Owner and the Design Agent the names of the manufacturers or fabricators for certain products, equipment, and systems identified in the Specifications and, where applicable, the name of the installing Subcontractor. The Owner may reply within 14 working days to the Contractor in writing, stating: (i) whether the Owner or the Design Agent has reasonable objection to any such proposed person manufacturer or fabricator; or (ii) whether the Owner or Design Agent requires additional time to review.

§ 5.2.5.2 The Contractor shall not contract with a proposed manufacturer, fabricator, or Subcontractor to whom the Owner or Design Agent has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.5.3 If the Owner or Design Agent has an objection to a manufacturer, fabricator, or Subcontractor proposed by the Contractor, the Contractor shall propose another to whom the Owner or Design Agent has no objection.

§ 5.2.5.4 The Contractor shall not substitute a manufacturer, fabricator, or Subcontractor previously selected if the Owner or Design Agent makes reasonable objection to such substitution.

§ 5.3 SUBCONTRACTUAL RELATIONS

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the

Subcontractor's Work, which the Contractor, by these Documents, assumes toward the Owner and Design Agent. Upon the request of the User Agency and/or the Owner, the Contractor shall provide the User Agency and/or the Owner with copies of each subcontract agreement. Each subcontract agreement shall preserve and protect the rights of the Owner and Design Agent under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 CONTINGENT ASSIGNMENT OF SUBCONTRACTS

- § 5.4.1** Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that
- .1 assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor in writing; and
 - .2 assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

(Paragraph deleted)

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 working days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ 5.4.3 Upon such assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 OWNER'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS

§ 6.1.1 The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project or other construction or operations on the site under Conditions of the Contract identical or substantially similar to these including those portions related to insurance and waiver of subrogation.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each separate contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with other separate contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to the construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, separate contractors and the Owner until subsequently revised.

§ 6.1.4 Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces, the Owner shall be deemed to be subject to the same obligations and to have the same rights that apply to the Contractor under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6 and Articles 10, 11 and 12.

§ 6.2 MUTUAL RESPONSIBILITY

§ 6.2.1 The Contractor shall afford the Owner and separate contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

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§ 6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a separate contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly report to the Design Agent apparent discrepancies or defects in such other construction that would render it unsuitable for such proper execution and results. Failure of the Contractor so to report shall constitute an acknowledgment that the Owner's or separate contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work, except as to defects not then reasonably discoverable.

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a separate contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a separate contractor's delays, improperly timed activities, damage to the Work or defective construction.

§ 6.2.4 The Contractor shall promptly remedy damage the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or separate contractors as provided in Section 10.2.5.

§ 6.2.5 The Owner and each separate contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.3 OWNER'S RIGHT TO CLEAN UP

If a dispute arises among the Contractor, separate contractors and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 GENERAL

§ 7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ 7.1.2 A Change Order shall be based upon agreement between the Owner and the Contractor; a Construction Change Directive requires agreement by the Owner and may or may not be agreed to by the Contractor; an order for a minor change in the Work may be issued by the Design Agent alone.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents, and the Contractor shall proceed promptly, unless otherwise provided in the Change Order, Construction Change Directive or order for a minor change in the Work.

§ 7.2 CHANGE ORDERS

§ 7.2.1 A Change Order is a written instrument prepared by the Contractor and signed by the Owner, Contractor and Design Agent stating their agreement upon all of the following:

- .1 The change in the Work;
- .2 The amount of the adjustment, if any, in the Contract Sum; and
- .3 The extent of the adjustment, if any, in the Contract Time.

§ 7.2.2 Subsequent to the approval of a Change Order as provided in § 7.1.2, whether such Change Order changes the Contract Sum or Contract Time or both, no additional claim related to such Change Order will be considered by the Owner. Any change, once incorporated into a Change Order, is all inclusive, and includes all factors that could have been considered at the time of the Change Order such as Project impact or schedule "ripple" effect.

§ 7.3 CONSTRUCTION CHANGE DIRECTIVES

§ 7.3.1 A Construction Change Directive is a written order prepared by the Design Agent and signed by the Owner, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ 7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ 7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- .1 Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- .2 Unit prices stated in the Contract Documents or subsequently agreed upon;
- .3 Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- .4 As provided in Section 7.3.7.

§ 7.3.4 Deleted.

§ 7.3.5 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Design Agent of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

§ 7.3.6 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.3.7 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Design Agent shall determine the method and the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in Section 7.3.1. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Design Agent may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.7 shall be limited to the following:

- .1 Costs of labor, including social security, old age and unemployment insurance, fringe benefits required by agreement or custom, and workers' compensation insurance;
- .2 Costs of materials, supplies and equipment, including cost of delivery;
- .3 Rental costs of machinery and equipment, exclusive of hand tools; or
- .4 Costs of premiums for all bonds and insurance and permit fees related to the Work..

§ 7.3.8 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Design Agent. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Design Agent will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Design Agent determines, in the Design Agent's professional judgment, to be reasonably justified. The Design Agent's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

§ 7.3.10 When the Owner and Contractor agree with a determination made by the Design Agent concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Contractor will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ 7.3.11 The combined overhead and profit included in the total cost to the Owner for a change in the Work shall be based on the following schedule:

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- .1 For the Contractor, for work performed by the Contractor's own forces, an amount not to exceed ten (10%) percent of the cost.
- .2 For the Contractor, for work performed by the Contractor's Subcontractors, an amount not to exceed five (5%) of the amount due to the Subcontractors.
- .3 For each Subcontractor, for work performed by the Subcontractor's own forces, an amount not to exceed ten (10%) percent of the cost.
- .4 Where the Work represents both additions and deletions and results in a net increase, the allowable overhead and profit shall be in accordance with this Section 7.3.11, but in no event shall the amount exceed fifteen (15%) percent of the net increase in the cost of the Work.
- .5 Overhead and profit is to include the Contractor's project management and supervisory costs, all administrative expenses and personnel, change estimate preparation, mobilization, setup & breakdown, meetings, all safety related costs, cleanup costs and storage costs pertaining to the changes in the work.
- .6 The fee increase to any permit required by the additional work is allowed to be added to the Change Order costs. However, the Contractor is required to submit proof that the additional fee was paid to the presiding authority.
- .7 In order to facilitate checking of quotations for extras or credits, all proposals, except those so minor that their propriety can be seen by inspection, shall be accompanied by a complete itemization of costs including labor, materials and Subcontracts. Labor and materials shall be itemized in the manner prescribed above. Where major cost items are Subcontracts, they shall be itemized also.

§ 7.3.12 All proposals with an aggregate cost equal to or in excess of \$500.00 shall be accompanied by a detailed itemization of costs, including labor, materials (quantities and prices), and Subcontracts, in a form acceptable to the Owner. In no event will a change order request reflecting an aggregate cost equal to or in excess of \$500.00 be approved without such itemization. All suppliers, vendor and subcontractor goods shall also have the detailed itemization as indicated above.

§ 7.4 MINOR CHANGES IN THE WORK

The Design Agent with the prior written approval of the Owner has authority to order minor changes in the Work not involving adjustment in the Contract Sum or extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such changes will be affected by written order signed by the Design Agent and shall be binding on the Owner and Contractor.

ARTICLE 8 TIME

§ 8.1 DEFINITIONS

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

The date of commencement of the Work is the date established in Section 3.1 of the Agreement..

(Paragraph deleted)

§ 8.1.3 The date of Substantial Completion is the date certified by the Design Agent in accordance with Section 9.8.

§ 8.1.4 Deleted.

§ 8.2 PROGRESS AND COMPLETION

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ 8.2.2 The Contractor shall not except by agreement or instruction of the Owner in writing, prematurely commence operations on the site or elsewhere prior to the effective date of insurance required by Article 11 to be furnished by the Contractor and Owner. The date of commencement of the Work shall not be changed by the effective date of such insurance.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

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§ 8.3 DELAYS AND EXTENSIONS OF TIME

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by an act or neglect of the Owner or Design Agent, or of an employee of either, or of a separate contractor employed by the Owner; or by changes ordered in the Work; or by labor disputes, fire, unusual delay in deliveries, unavoidable casualties or other causes beyond the Contractor's control, then the Contract Time shall be extended by Change Order for such reasonable time as the Owner may determine.

§ 8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Article 15.

§ 8.3.3 This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 CONTRACT SUM

The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.2 SCHEDULE OF VALUES

Within 20 working days of the issuance of the Purchase Order, and promptly if revision is necessary from time to time as a result of a Change Order, the Contractor shall submit to the Owner, before the first Application for Payment, a schedule of values allocating the entire Contract Sum to the various portions of the Work and prepared in such form and supported by such data to substantiate its accuracy as the Design Agent and the Owner may require. This schedule, if and when approved by the Design Agent and the Owner in writing, shall be used as a basis for reviewing the Contractor's Applications for Payment.

§ 9.3 APPLICATIONS FOR PAYMENT

§ 9.3.1 At least 10 working days before the date established for each progress payment, the Contractor shall submit to the Design Agent and the Owner for approval an itemized Application for Payment prepared in accordance with the schedule of values for completed portions of the Work. Such application shall be notarized, if required, and supported by such data substantiating the Contractor's right to payment as the Owner or the Design Agent may require, such as copies of requisitions from Subcontractors and material suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ 9.3.1.1 All Applications for Payment for Change Orders must be accompanied by a Notice of Change in Purchase Order issued by the Owner, and if directed by the Owner, by the User Agency.

§ 9.3.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or material supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ 9.3.1.3 The form of Application for Payment shall be AIA Document G702, Application and Certification for Payment, supported by AIA Document G702A, Continuation Sheet.

§ 9.3.1.4 Until Substantial Completion, the Owner shall pay ninety-five (95%) percent of the amount due the Contractor on account of progress payments.

§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage and transportation to the site for such materials and equipment stored off the site.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall be

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free and clear of liens, claims, security interests or encumbrances in favor of the Contractor, Subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to the Work. The Contractor shall immediately satisfy any lien, claim, or encumbrance against the site where the Project is located and indemnify the Owner from and against all resulting costs and expenses, including without limitation, attorneys' fees.

§ 9.4 CERTIFICATES FOR PAYMENT

§ 9.4.1 The Design Agent will, within 7 working days after receipt of the Contractor's Application for Payment, either issue to the Owner a Certificate for Payment, with a copy to the Contractor, for such amount as the Design Agent determines is properly due, or notify the Contractor and Owner in writing of the Design Agent's reasons for withholding certification in whole or in part as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Design Agent to the Owner, based on the Design Agent's evaluation of the Work and the data comprising the Application for Payment, that, the Work has progressed to the point indicated and that the quality of the Work is in accordance with the Contract Documents. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion and to specific qualifications expressed by the Design Agent. The issuance of a Certificate for Payment will further constitute a representation that the Contractor is entitled to payment in the amount certified. However, the issuance of a Certificate for Payment will not be a representation that the Design Agent has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work, (2) reviewed construction means, methods, techniques, sequences or procedures, (3) reviewed copies of requisitions received from Subcontractors and material suppliers and other data requested by the Owner to substantiate the Contractor's right to payment, or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.4.3 The Contractor must submit all product literature, material and color samples with each Application for Payment, or as otherwise required by the Owner.

§ 9.5 DECISIONS TO WITHHOLD CERTIFICATION

§ 9.5.1 The Design Agent will withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Design Agent's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Design Agent is unable to certify payment in the amount of the Application, the Design Agent will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Design Agent cannot agree on a revised amount, the Design Agent will promptly issue a Certificate for Payment for the amount for which the Design Agent is able to make such representations to the Owner. The Design Agent may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Design Agent's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of:

- .1 defective Work not remedied;
- .2 third party claims filed or reasonable evidence indicating probable filing of such claims unless security acceptable to the Owner is provided by the Contractor;
- .3 failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment;
- .4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- .5 damage to the Owner or a separate contractor;
- .6 reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;
- .7 failure to carry out the Work in accordance with the Contract Documents; or
- .8 any other failure to comply with the obligations of the Contractor under the Contract Documents.

§ 9.5.2 When the above reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.3 The Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or material or equipment suppliers to whom the Contractor failed to make payment for Work properly performed or material or

equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Design Agent and the Design Agent will reflect such payment on the next Certificate for Payment.

§ 9.6 PROGRESS PAYMENTS

§ 9.6.1 After the Design Agent has issued a Certificate for Payment and the Owner has approved the Certificate for Payment in writing, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Design Agent.

§ 9.6.2 The Contractor shall pay each Subcontractor no later than 10 working days after receipt of payment from the Owner the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Design Agent will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Design Agent and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and material and equipment suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within 7 working days, the Owner shall have the right to contact Subcontractors to ascertain whether they have been properly paid. The Owner shall have the right to withhold payment(s) to the Contractor in the event that any Subcontractors or material and equipment suppliers have not been properly paid. Neither the Owner nor Design Agent shall have an obligation to pay or to see to the payment of money to a Subcontractor, except as may otherwise be required by law.

§ 9.6.5 Contractor payments to material and equipment suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors and suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, shall create any fiduciary liability or tort liability on the part of the Contractor for breach of trust or shall entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ 9.7 FAILURE OF PAYMENT

If the Design Agent does not issue a Certificate for Payment, through no fault of the Contractor, within 7 working days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within 7 working days after the date established in the Contract Documents the amount certified by the Design Agent or awarded by binding dispute resolution, then the Contractor may, upon 7 additional working days' written notice to the Owner and Design Agent, make a claim for payment as provided under the provisions of applicable law.

§ 9.8 SUBSTANTIAL COMPLETION

§ 9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Design Agent a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

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§ 9.8.3 Upon receipt of the Contractor's list, the Design Agent will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Design Agent's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Design Agent. In such case, the Contractor shall then submit a request for another inspection by the Design Agent to determine Substantial Completion. The Design Agent will perform no more than 2 inspections to determine whether the Work or a designated portion thereof has attained Substantial Completion in accordance with the Contract Documents. The Owner is entitled to reimbursement from the Contractor for amounts paid to the Design Agent for any additional inspections.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Design Agent will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion, shall establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the Contractor shall finish all items on the list accompanying the Certificate.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in such Certificate. Upon such acceptance and consent of surety, if any, the Owner shall make payment less the amount of five (5%) percent to be retained by the Owner in accordance with R.I. Gen. Laws § 37-12-10.1. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.9 PARTIAL OCCUPANCY OR USE

§ 9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer as required under Section 11.3.1.5 and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Design Agent as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Design Agent.

§ 9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor and Design Agent shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ 9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

§ 9.10 FINAL COMPLETION AND FINAL PAYMENT

§ 9.10.1 Upon receipt of the Contractor's written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Design Agent will promptly make such inspection and, when the Design Agent finds the Work acceptable under the Contract Documents and the Contract fully performed, the Design Agent will promptly issue a final Certificate for Payment stating that to the best of the Design Agent's knowledge, information and belief, and on the basis of the Design Agent's on-site visits and inspections, the Work has been completed in accordance with terms and conditions of the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Design Agent's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled. The Design Agent will perform no more than 2 inspections to determine whether the Work or a designated portion thereof has attained Final Completion in accordance with the Contract Documents. The Owner is entitled to reimbursement from the Contractor for amounts paid to the Design Agent for any additional inspections.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Design Agent (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least 30 working days' prior written notice has been given to the Owner, (3) a written statement that the Contractor knows of no substantial reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5), if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner, and (6) all other close-out documents required by the Owner, including without limitation, all as-built plans, warranties, manuals, and other materials set forth in the Contract Documents. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien. If such lien remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging such lien, including all costs and reasonable attorneys' fees.

§ 9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Design Agent so confirms, the Owner shall, upon application by the Contractor and certification by the Design Agent, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Design Agent prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

§ 9.10.4 The making of final payment shall constitute a waiver of Claims by the Owner except those arising from:

- .1 liens, Claims, security interests, or encumbrances arising out of the Contract and unsettled;
- .2 failure of the Work to comply with the requirements of the Contract Documents;
- .3 terms of special warranties required by the Contract Documents; or
- .4 claims permitted under the State of Rhode Island General Conditions of Purchase Regulation.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor or material supplier shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

§ 9.11 The Contractor and the Contractor's surety shall be liable for and shall pay the Owner as liquidated damages the sums specified in the Solicitation and Bid Form, or if completed, the amount set forth in Section 3.4 of the Agreement.

§ 9.12 Warranties required by the Contract Documents shall commence on the date of Final Completion of the Work.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 SAFETY PRECAUTIONS AND PROGRAMS

The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.2 SAFETY OF PERSONS AND PROPERTY

§ 10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury or loss to:

- .1 employees on the Work and other persons who may be affected thereby;
- .2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody or control of the Contractor or the Contractor's Subcontractors or Sub-subcontractors; and
- .3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

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§ 10.2.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury or loss.

§ 10.2.3 The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations and notifying owners and users of adjacent sites and utilities.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel and in consultation with the appropriate governmental authorities.

§ 10.2.4.1 When use or storage of explosives, or other hazardous materials, substances or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall give the User Agency and the Owner reasonable advance notice.

§ 10.2.4.2 If the Contract Documents require the Contractor to handle materials or substances that under certain circumstances may be designated as hazardous, the Contractor shall handle such materials in an appropriate manner.

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3, except damage or loss attributable to acts or omissions of the Owner or Design Agent or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Design Agent.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ 10.2.8 INJURY OR DAMAGE TO PERSON OR PROPERTY

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, written notice of such injury or damage, whether or not insured, shall be given to the other party within a reasonable time. The notice shall provide sufficient detail to enable the other party to investigate the matter.

§ 10.3 HAZARDOUS MATERIALS

§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and report the condition to the Owner and Design Agent in writing.

§ 10.3.2 Upon receipt of the Contractor's written notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Design Agent the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of such material or substance or who are to perform the task of removal or safe containment of such material or substance. The Contractor and the Design Agent will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons

or entities proposed by the Owner. If either the Contractor or Design Agent has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Design Agent have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased in the amount of the Contractor's reasonable additional costs of shut-down, delay and start-up.

§ 10.3.3 To the extent permitted by the provisions of R.I. Gen. Laws §§ 9-31-1 et seq., the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Design Agent, Design Agent's consultants and agents and employees of any of them from and against claims, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss or expense is due to the fault or negligence of the party seeking indemnity.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

§ 10.3.5 The Contractor shall indemnify the Owner for the cost and expense the Owner incurs (1) for remediation of a material or substance the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

§ 10.3.6 If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall indemnify the Contractor for all cost and expense thereby incurred.

§ 10.4 EMERGENCIES

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 CONTRACTOR'S LIABILITY INSURANCE

§ 11.1.1 The Contractor shall purchase from and maintain in a company or companies lawfully authorized to do business in the jurisdiction in which the Project is located such insurance as is specified in the Solicitation and as will protect the Contractor from claims set forth below which may arise out of or result from the Contractor's operations and completed operations under the Contract and for which the Contractor may be legally liable, whether such operations be by the Contractor or by a Subcontractor or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

- .1 Claims under workers' compensation, disability benefit and other similar employee benefit acts that are applicable to the Work to be performed;
- .2 Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;
- .3 Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;
- .4 Claims for damages insured by usual personal injury liability coverage;
- .5 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;
- .6 Claims for damages because of bodily injury, death of a person or property damage arising out of ownership, maintenance or use of a motor vehicle;
- .7 Claims for bodily injury or property damage arising out of completed operations; and
- .8 Claims involving contractual liability insurance applicable to the Contractor's obligations under Section 3.18.

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§ 11.1.1.2 The Contractor's liability insurance shall include all major coverages and be on a comprehensive general liability basis.

§ 11.1.2 The insurance required by Section 11.1.1 shall be written for not less than limits of liability specified in the Contract Documents or required by law, whichever coverage is greater. Coverages, whether written on an occurrence or claims-made basis, shall be maintained without interruption from the date of commencement of the Work until the date of final payment and termination of any coverage required to be maintained after final payment, and, with respect to the Contractor's completed operations coverage, until the expiration of the period for correction of Work or for such other period for maintenance of completed operations coverage as specified in the Contract Documents.

§ 11.1.3 Certificates of insurance as specified in the Solicitation and as otherwise acceptable to the Owner shall be filed with the Owner and the User Agency prior to commencement of the Work and thereafter upon renewal or replacement of each required policy of insurance. These certificates and the insurance policies required by this Section 11.1 shall contain a provision that coverages afforded under the policies will not be canceled or allowed to expire until at least 30 working days' prior written notice has been given to the Owner and the User Agency. An additional certificate evidencing continuation of liability coverage, including coverage for completed operations, shall be submitted with the final Application for Payment as required by Section 9.10.2 and thereafter upon renewal or replacement of such coverage until the expiration of the time required by Section 11.1.2. Information concerning reduction of coverage on account of revised limits or claims paid under the General Aggregate, or both, shall be furnished by the Contractor with reasonable promptness.

§ 11.1.4 The Contractor shall cause the commercial liability coverage required by the Contract Documents to include (1) the Owner, the User Agency, and their elected and appointed officials, members, employees, and agents, the Design Agent and the Design Agent's consultants as additional insureds for claims caused in whole or in part by the Contractor's acts or omissions during the Contractor's operations; and (2) the Owner, the User Agency, and their elected and appointed officials, members, employees, and agents, as additional insureds for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's completed operations.

§ 11.1.5 The Contractor shall be responsible for the prompt payment to the Owner of any deductible amounts under any insurance policies required under the Contract Documents for claims made pursuant to such policies.

§ 11.2 OWNER'S LIABILITY INSURANCE.

§ 11.2.1 The Contractor shall furnish the Owner and the User Agency, through the Design Agent, an insurance certificate providing Owner's Protective Liability extended to include the interests of the Design Agent, and to protect the Owner, User Agency, and Design Agent from any liability which might be incurred against any of them as a result of any operation of the Contractor or Subcontractors or their employees or anyone for whom either the Contractor or Subcontractors are responsible. Such insurance shall be written for the same limits as the Contractor's commercial general liability insurance and shall include the same coverage.

§ 11.2.2 If the Owner engages separate contractors to perform work for, or in or around, the Project, it shall require in its contracts with each separate contractor that Contractor and its officers, directors, partners, members, employees, and agents shall be: (i) named as additional insureds on a primary, noncontributory basis to any commercial general liability, pollution liability, and excess liability insurance policies; and (ii) provided a waiver of subrogation on all workers compensation and professional liability insurance policies.

§ 11.3 PROPERTY INSURANCE

§ 11.3.1 The Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the state of Rhode Island, property insurance written on a builder's risk "all-risk" or equivalent policy form in the amount of the initial Contract Sum, plus value of subsequent Contract Modifications and cost of materials supplied or installed by others, comprising total value for the entire Project at the site on a replacement cost basis without optional deductibles. Such property insurance shall be maintained, unless otherwise provided in the Contract Documents or otherwise agreed in writing by all persons and entities who are beneficiaries of such insurance, until final payment has been made as provided in Section 9.10 or until no person or entity other than the Owner has an insurable interest in the property required by this Section 11.3 to be covered, whichever is later. This insurance shall include interests of the Owner, the User Agency, the Contractor, Subcontractors and Sub-subcontractors in the Project. If the Owner and/or

the User Agency incur any damages by failure of the Contractor to maintain such insurance, then the Contractor shall bear all reasonable cost resulting from such failure.

§ 11.3.1.1 Property insurance shall be on an "all-risk" or equivalent policy form and shall include, without limitation, insurance against the perils of fire (with extended coverage) and physical loss or damage including, without duplication of coverage, theft, vandalism, malicious mischief, collapse, earthquake, flood, windstorm, falsework, testing and startup, temporary buildings and debris removal including demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for Design Agent's and Contractor's services and expenses required as a result of such insured loss.

§ 11.3.1.2 Deleted.

§ 11.3.1.3 If the property insurance requires deductibles, the Owner shall pay costs not covered because of such deductibles.

§ 11.3.1.4 This property insurance shall cover portions of the Work stored off the site, and also portions of the Work in transit.

§ 11.3.1.5 Partial occupancy or use in accordance with Section 9.9 shall not commence until the insurance company or companies providing property insurance have consented to such partial occupancy or use by endorsement or otherwise. The Contractor shall take reasonable steps to obtain consent of the insurance company or companies and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

§ 11.3.2 Deleted.

§ 11.3.3 Deleted.

§ 11.3.4 Deleted.

§ 11.3.5 If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, the Owner shall waive all rights in accordance with the terms of Section 11.3.7 for damages caused by fire or other causes of loss covered by this separate property insurance. All separate policies shall provide this waiver of subrogation by endorsement or otherwise.

§ 11.3.6 Before an exposure to loss may occur, the Contractor shall file with the Owner a copy of each policy that includes insurance coverages required by this Section 11.3. Each policy shall contain all generally applicable conditions, definitions, exclusions and endorsements related to this Project. Each policy shall contain a provision that the policy will not be canceled or allowed to expire, and that its limits will not be reduced, until at least 30 working days' prior written notice has been given to the Owner and the User Agency.

§ 11.3.7 WAIVERS OF SUBROGATION

The Contractor waives all rights against the Owner and the User Agency and any of their subcontractors, sub-subcontractors, agents and employees, and (2) the Design Agent, Design Agent's consultants, separate contractors described in Article 6, if any, and any of their subcontractors, sub-subcontractors, agents and employees, for damages caused by fire or other causes of loss to the extent covered by property insurance obtained pursuant to this Section 11.3 or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance held by the Owner as fiduciary. The Owner or Contractor, as appropriate, shall require of the Design Agent, Design Agent's consultants, separate contractors described in Article 6, if any, and the subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

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§ 11.3.8 A loss insured under this property insurance shall be adjusted by the Contractor as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.3.10. The Contractor shall pay Subcontractors their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors to make payments to their Sub-subcontractors in similar manner.

§ 11.3.9 If required in writing by a party in interest, the Owner as fiduciary shall, upon occurrence of an insured loss, give bond for proper performance of the Contractor's duties. The cost of required bonds shall be charged against proceeds received as fiduciary. The Contractor shall deposit in a separate account proceeds so received, which the Contractor shall distribute in accordance with such agreement as the parties in interest may reach, or as determined in accordance with the method of binding dispute resolution selected in the Agreement between the Owner and Contractor. If after such loss no other special agreement is made and unless the Owner terminates the Contract for convenience, replacement of damaged property shall be performed by the Contractor after notification of a Change in the Work in accordance with Article 7.

§ 11.3.10 The Contractor as fiduciary shall have power to adjust and settle a loss with insurers unless one of the parties in interest shall object in writing within 5 working days after occurrence of loss to the Contractor's exercise of this power; if such objection is made, the dispute shall be resolved in the manner selected by the Owner and Contractor as the method of binding dispute resolution in the Agreement.

§ 11.4 PERFORMANCE BOND AND PAYMENT BOND

§ 11.4.1 The Contractor shall furnish bonds covering faithful performance of the Contract and payment of obligations arising thereunder as stipulated in the Solicitation.

§ 11.4.2 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 UNCOVERING OF WORK

§ 12.1.1 If a portion of the Work is covered contrary to the Design Agent's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Design Agent, be uncovered for the Design Agent's examination and be replaced at the Contractor's expense without change in the Contract Time.

§ 12.1.2 If a portion of the Work has been covered that the Design Agent has not specifically requested to examine prior to its being covered, the Design Agent may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement shall, by appropriate Change Order, be at the Owner's expense. If such Work is not in accordance with the Contract Documents, such costs and the cost of correction shall be at the Contractor's expense unless the condition was caused by the Owner or a separate contractor in which event the Owner shall be responsible for payment of such costs.

§ 12.2 CORRECTION OF WORK

§ 12.2.1 BEFORE OR AFTER SUBSTANTIAL COMPLETION

The Contractor shall promptly correct Work rejected by the Design Agent or failing to conform to the requirements of the Contract Documents, whether discovered before or after Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Design Agent's services and expenses made necessary thereby, shall be at the Contractor's expense.

§ 12.2.2 AFTER SUBSTANTIAL COMPLETION

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Final Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of an applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of written notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. If

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the Contractor fails to correct nonconforming Work within a reasonable time after receipt of notice from the Owner or Design Agent, the Owner may correct it in accordance with Section 2.4.

§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ 12.2.2.3 The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§ 12.2.2.4 Upon request by the Owner and prior to the expiration of one year from the date of Final Completion, the Design Agent will conduct and the Contractor shall attend 2 meetings with the Owner to review the facility operations and performance.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction, whether completed or partially completed, of the Owner or separate contractors caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.3 ACCEPTANCE OF NONCONFORMING WORK

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 GOVERNING LAW

The Contract shall be governed by the law of the State of Rhode Island.

§ 13.2 SUCCESSORS AND ASSIGNS

§ 13.2.1 The Owner and Contractor respectively bind themselves, their successors, assigns and legal representatives to covenants, agreements and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make such an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to any executive, legislative, judicial, regulatory, or administrative body of the state, or any political subdivision thereof, including without limitation, any department, division, agency, commission, board, office, bureau, authority, school, water, or fire district, or other agency of Rhode Island state or local government that exercises governmental functions, any other governmental authority, and any quasi-public corporation and/or body corporate and politic. The Contractor shall execute all consents reasonably required to facilitate such assignment.

§ 13.3 WRITTEN NOTICE

Written notice shall be deemed to have been duly served if delivered in person to the individual, to a member of the firm or entity, or to an officer of the corporation for which it was intended; or if delivered at, or sent by registered or certified mail or by courier service providing proof of delivery to, the last business address known to the party giving notice, or when received, if manually delivered or transmitted by electronic mail or facsimile to the last such address known to the party giving notice.

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§ 13.4 RIGHTS AND REMEDIES

§ 13.4.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights and remedies otherwise imposed or available by law.

§ 13.4.2 No action or failure to act by the Owner, Design Agent or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach there under, except as may be specifically agreed in writing.

§ 13.5 TESTS AND INSPECTIONS

§ 13.5.1 Tests, inspections and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections and approvals. The Contractor shall give the Design Agent timely notice of when and where tests and inspections are to be made so that the Design Agent may be present for such procedures. The Owner shall bear costs of (1) tests, inspections or approvals that do not become requirements until after bids are received or negotiations concluded, and (2) tests, inspections or approvals where building codes or applicable laws or regulations prohibit the Owner from delegating their cost to the Contractor.

§ 13.5.2 If the Design Agent, Owner or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection or approval not included under Section 13.5.1, the Design Agent will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection or approval by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Design Agent of when and where tests and inspections are to be made so that the Design Agent may be present for such procedures. Such costs, except as provided in Section 13.5.3, shall be at the Owner's expense.

§ 13.5.3 If such procedures for testing, inspection or approval under Sections 13.5.1 and 13.5.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure including those of repeated procedures and compensation for the Design Agent's services and expenses shall be at the Contractor's expense.

§ 13.5.4 Required certificates of testing, inspection or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Design Agent.

§ 13.5.5 If the Design Agent is to observe tests, inspections or approvals required by the Contract Documents, the Design Agent will do so promptly and, where practicable, at the normal place of testing.

§ 13.5.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.6 INTEREST

No interest shall be due or payable on account of any payment due or unpaid under the Contract Documents except in accordance with the provisions of "Prompt Payment by Department of Administration," R.I. Gen. Laws §§ 42-11.1-1 et seq.

§ 13.7 TIME LIMITS ON CLAIMS

The Owner and Contractor shall commence all claims and causes of action, whether in contract, tort, breach of warranty or otherwise, against the other arising out of or related to the Contract in accordance with the requirements of the final dispute resolution method selected in the Agreement within the time period specified by applicable law. The Owner and Contractor waive all claims and causes of action not commenced in accordance with this Section 13.7.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 TERMINATION BY THE CONTRACTOR

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 calendar days through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons

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or entities performing portions of the Work under direct or indirect contract with the Contractor, for any of the following reasons:

- .1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- .2 An act of government, such as a declaration of national emergency that requires all Work to be stopped; or
- .3 Because the Design Agent has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1

§ 14.1.2 Deleted.

§ 14.1.3 If one of the reasons described in Section 14.1.1 exists, the Contractor may, upon 7 working days' written notice to the Owner and Design Agent, terminate the Contract and recover from the Owner payment for Work executed.

§ 14.1.4 If the Work is stopped for a period of 60 calendar days through no act or fault of the Contractor or a Subcontractor or their agents or employees or any other persons performing portions of the Work under contract with the Contractor because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents with respect to matters important to the progress of the Work, the Contractor may, upon 7 additional days' written notice to the Owner and the Design Agent, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.2 TERMINATION BY THE OWNER FOR CAUSE

§ 14.2.1 The Owner may terminate the Contract if the Contractor:

- .1 refuses or fails to supply enough properly skilled workers or proper materials;
- .2 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;
- .3 disregards or fails to comply with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority;
- .4 otherwise is guilty of breach of a provision of the Contract Documents; or
- .5 cancels or the Contractor or the Owner receives notice of cancellation or nonrenewal of any insurance required under the Contract Documents.

§ 14.2.2 When any of the above reasons exist, the Owner, upon certification by the Initial Decision Maker that sufficient cause exists to justify such action, may without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, 7 working days' written notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- .1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- .2 Accept assignment of subcontracts pursuant to Section 5.4; and
- .3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Design Agent's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 SUSPENSION BY THE OWNER FOR CONVENIENCE

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work in whole or in part for such period of time as the Owner may determine.

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§ 14.3.2 The
(Paragraphs deleted)

Owner shall not be liable to the Contractor or any Subcontractor for claims or damages of any nature caused by or arising out of any delays. The sole remedy against the Owner for delays shall be the allowance of additional time for completion of the Work in accordance with the provisions of Section 8.3.1.

§ 14.4 TERMINATION BY THE OWNER FOR CONVENIENCE

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of written notice from the Owner of such termination for the Owner's convenience, the Contractor shall:

- .1 cease operations as directed by the Owner in the notice;
- .2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and
- .3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive payment for Work executed, and costs incurred by reason of such termination.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 CLAIMS

§ 15.1.1 DEFINITION

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim.

§ 15.1.2 NOTICE OF CLAIMS

Claims by either the Owner or Contractor must be initiated by written notice to the other party. Such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly serviced if delivered in person, by mail, by courier, or by electronic transmission. Claims by either party must be initiated within 21 working days after occurrence of the event giving rise to such Claim or within 21 working days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ 15.1.3 CONTINUING CONTRACT PERFORMANCE

Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents. The Design Agent will prepare Change Orders and issue Certificates for Payment in accordance with the decisions of the Initial Decision Maker.

§ 15.1.4 CLAIMS FOR ADDITIONAL COST

If the Contractor wishes to make a Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.5 CLAIMS FOR ADDITIONAL TIME

§ 15.1.5.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, written notice as provided herein shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.5.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated and had an adverse effect on the scheduled construction.

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§ 15.1.5.3 Claims for increase in the Contract Time shall set forth in detail the circumstances that form the basis for the Claim, the date upon which each cause of delay began to affect the progress of the Work, the date upon which each cause of delay ceased to affect the progress of the Work and the number of days' increase in the Contract Time claimed as a consequence of each such cause of delay. The Contractor shall provide such supporting documentation as the Owner may require including, where appropriate, a revised construction schedule indicating all the activities affected by the circumstances forming the basis of the Claim.

§ 15.1.5.4 The Contractor shall not be entitled to a separate increase in the Contract Time for each one of the number of causes of delay which may have concurrent or interrelated effects on the progress of the Work, or for concurrent delays due to the fault of the Contractor.

§ 15.1.6

(Paragraphs deleted)

Deleted.

§ 15.2 INITIAL DECISION

§ 15.2.1 Claims shall be referred to the Initial Decision Maker for initial decision. The Purchasing Agent appointed pursuant to the provisions of the "State Purchases Act," R.I. Gen. Laws § 37-2-1 et seq., will serve as the Initial Decision Maker in accordance with the provisions of the State Purchases Act, State of Rhode Island Procurement Regulations, and this Section 15.2.1. An initial decision shall be required as a condition precedent to binding dispute resolution pursuant to Section 15.3.1 of any Claim arising prior to the date final payment is due.

§ 15.2.2 Deleted.

§ 15.2.3 Deleted.

§ 15.2.4 Deleted.

§ 15.2.5 Deleted.

§ 15.2.6 Deleted.

§ 15.2.6.1 Deleted.

§ 15.2.7 Deleted.

§ 15.2.8 Deleted.

§ 15.3 MEDIATION

§ 15.3.1 For any Claim not resolved by the Initial Decision Maker procedures set forth in Section 15.2.1, and prior to the implementation of the binding dispute resolution procedures set forth in Section 15.4.1, the Contractor or the Design Agent shall have the option to pursue mediation, exercisable by written notice to the Owner within 30 calendar days of an Initial Decision. In the event of the exercise of such option by the Contractor or the Design Agent, the Owner and the Contractor or the Design Agent shall attempt to select a mediator, and in the event that the Owner and the Contractor or the Design Agent cannot agree on a mediator, either party may apply in writing to the Presiding Justice of the Providence County Superior Court, with a copy to the other, with a request for the court to appoint a mediator, and the costs of the mediator shall be borne equally by both parties.

§ 15.3.2 Deleted.

§ 15.3.3 Deleted.

§ 15.4 BINDING DISPUTE RESOLUTION

§ 15.4.1 For any Claim not resolved by the Initial Decision Maker procedures set forth in Section 15.2.1, or mediation at the option of the Contractor pursuant to Section 15.3.1, the method of binding dispute resolution shall be determined in accordance with the provisions of the "Public Works Arbitration Act," R.I. Gen. Laws §§ 37-16-1 et seq.

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(Paragraphs deleted)

§ 15.4.4 Deleted.

§ 15.4.4.1 Deleted.

§ 15.4.4.2 Deleted.

§ 15.4.4.3 Deleted.

§ 16 COMPLIANCE WITH APPLICABLE LAW

The Contractor and its Subcontractors shall comply with all applicable federal, state, and local laws.

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**THE STATE OF RHODE ISLAND, acting by
and through its Department of Administration,
Division of Purchases**

OWNER *(Signature)*

(Printed name and title)

CONTRACTOR *(Signature)*

(Printed name and title)

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00 50 00 – CONTRACTING FORMS

PART 1 - GENERAL

1.1 COPYRIGHT

- A. Contractor is responsible for obtaining a valid license to use all copyrighted documents specified or included in the Project Manual.

1.2 AGREEMENT AND CONDITIONS OF THE CONTRACT

- A. See Section 00 5200 for the Agreement form to be executed.
- B. See Section 00 7200 for the General Conditions.

1.3 FORMS

- A. Use the following forms for the specified purposes unless otherwise indicated elsewhere in the Contract Documents.
- B. Bond Forms:
 - a. Performance Bond and Payment Bond Forms: AIA A312
- C. Release of Lien:
 - a. Release of Liens Form: AIA G706A
 - b. RIC Waiver of Liens Form 01 20 00
- D. Insurance certificate, supplementary attachment:
 - a. ACORD Certificate of Insurance Form: AIA G715

1.4 REFERENCE STANDARDS

- A. AIA G706A – Release of Liens: 1994.
- B. AIA A312 - Performance Bond: 2010 and Payment Bond: 2010.
- C. AIA G715 – ACORD Certificate of Insurance: 1991.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

LLB ARCHITECTS
AUGUST 30, 2024

RHODE ISLAND COLLEGE
RIC CYBER COMMAND CENTER – ALGER HALL
CONSTRUCTION DOCUMENTS

00 51 00 – NOTICE OF AWARD

RI State Purchasing shall issue the Notice of Tentative Award.

END OF SECTION

00 52 00 – AGREEMENT FORM

PART 1 - GENERAL

1.1 AGREEMENT FORM

- A. The Agreement Form to be utilized on this project is AIA Document A101-2017 as amended, a copy of which follows this page.
- B. Agreement made as of the date of issue of the Purchase Order for this Work.
- C. This Agreement is entered into as of the date of the applicable Purchase Order and is assumed as executed once the Purchase Order is issued.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXECUTION OF THE AGREEMENT

- A. Following the issuance of the Notice of Tentative Award, the user Agency, Design Team and Contractor shall convene a Pre-Award Conference. Meeting minutes from the Pre-Award Conference and acceptance of the minutes by the Contractor shall be incorporated into the Contract.
- B. The User Agency will transmit the A101-2017 to the Contractor for signature. The Contractor will sign and return the contract to the User Agency, who then transmits it to the RI State Purchasing Office for final signatures.

END OF SECTION

LLB ARCHITECTS
AUGUST 30, 2024

RHODE ISLAND COLLEGE
RIC CYBER COMMAND CENTER – ALGER HALL
CONSTRUCTION DOCUMENTS

00 55 00 – NOTICE TO PROCEED

RI State Purchasing shall issue the Purchase Order. The User Agency shall issue the Notice to Proceed, per AIA A101-2017 §3.1.

END OF SECTION

00 61 00 – BOND FORMS

The RI State Purchasing Notice of Tentative Award indicates the required bonding forms for this project.

END OF SECTION

00 62 00 – CERTIFICATES AND OTHER FORMS

PART 1 - GENERAL

1.1 ARCHITECT PROVIDED CERTIFICATES AND PROJECT FORMS

- a. Submittal Cover Page: Refer to 01 33 01
- b. Submittal Product Form: Refer to 01 33 02

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

00 65 00 – CLOSEOUT FORMS

PART 1 - GENERAL

1.1 CLOSEOUT FORMS

- A. The following forms are required as part of the closeout documentation:
- a. Transmittal on Contractor's letterhead for each package of documents transmitted.
 - b. Upon Substantial Completion, the User Agency shall provide copies of the AIA Documents indicated in Section 01 74 19.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

00 72 00 – GENERAL CONDITIONS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

- A. The General Conditions to be utilized on this project are AIA Document A201-2007 as amended, a copy of which follows this page.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXECUTION OF THE GENERAL CONDITIONS

- A. The User Agency will transmit the A201-2007 to the Contractor. The contractor shall initial and return to the User Agency, who then transmits it to the RI State Purchasing Office.

END OF SECTION

00 73 43 – PREVAILING WAGE RATES

The State of Rhode Island Department of Labor, Division of Professional Regulation General Decision Modification document is an integral part of the Bid Documents for use in fulfilling prevailing wage rate requirements. A copy is available linked to the web site of the State of Rhode Island Department of Administration, Division of Purchases. Contractors working on RI Prevailing Wage projects must adjust employee hourly rates every July 1 in accordance with updated Davis Bacon rates. These rates may be obtained at the following website:

www.wdol.gov/dba.aspx

The Division of Purchases Web Site Address is: <http://www.purchasing.ri.gov/RVIP/Info.asp>

The link for the US Government prevailing wage tables is: <http://www.purchasing.ri.gov/bidinfo/geninfo/geninfo.aspx>

Applicable Rhode Island labor laws may be found at: <http://www.dlt.ri.gov/pw/>

END OF SECTION

00 91 13 – ADDENDA AND MODIFICATIONS

PART 1 - GENERAL

- A. As of the time of publication of this Project Manual, no Addenda had been issued.
- B. Should Addenda be issued during the Bid Period, they will augment this Document and become a part of the Project Manual.
- C. Such Addenda and Modifications when issued, with reference to the Project Manual, the General Conditions, Supplemental General Conditions, Drawings or Specifications, shall be inserted following this page and become integral parts of the Contract Documents.

END OF SECTION

01 10 00 – SUMMARY

PART 1 - GENERAL

1.1 PROJECT

- A. The Project consists of the construction of the following types of work:
 - a. Selective demolition in classrooms 101 and 102 in Alger Hall.
 - b. New interior fit-out of the two classrooms as depicted in the drawings.
 - c. Work on the roof and shaft on level 2 for new mechanical equipment serving the two classrooms.
 - d. Add a new door in Data Room 110D in Alger Hall. Provide card reader and electrified hardware per RIC's standards

1.2 CONTRACT DESCRIPTION

- A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 00 50 00 – Contracting Forms.

1.3 DESCRIPTION OF WORK

- A. Scope of demolition and removal work is shown on drawings plus as specified in Section 02 41 00
- B. Scope of alterations work is shown on drawings and as specified herein
- C. Architectural modifications: Refer to Document 01 35 16 Alteration Project Procedures

1.4 SCHEDULE

- A. The date of commencement of the Work shall be the later of: (i) the issuance of the Purchase Order by the Owner; and (ii) the date set forth in a notice to proceed issued by the User Agency.
- B. Ordering of products, coordination and preparatory work shall commence within 7 days of receipt of Purchase Order.
- C. Construction at the site can commence **DATE or NUMBER Calendar Days from Issuance of the Purchase Order** and shall be agreed upon with the User Agency.
- D. Substantial completion date is **NUMBER** Calendar Days from Issuance of the Purchase Order. This is the date to which liquidated damages may apply and may only be adjusted as provided for in the Contract Documents. Contractor shall be responsible for completing the submittals required for issue of a Purchase Order in a timely manner. No extension will be granted for purchasing delays.
- E. Final Completion is **DATE or NUMBER Calendar Days from Issuance of the Purchase Order**. This date represents the completion of all outstanding punchlist items and complete demobilization of the site.
- F. Cooperate with User Agency to minimize conflict and to facilitate the facility's operations.

1.5 ITEMS TO BE SALVAGED

- A. As indicated on drawings and in specifications.

1.6 SUBCONTRACTOR CERTIFICATION REQUIREMENTS

- A. Network/IT wiring to be installed by Panduit PCI Certified vendor and technicians. This includes wire runs and terminations.
- B. Security Systems shall be installed by Bosch Certified vendor and technicians.

- C. Door Access Hardware shall be wired and installed by DSX Certified vendors and technicians.
- D. Forbo certification for Flotex flooring installations.
- E. See individual Specification sections.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 14 00 – COORDINATION OF WORK WITH USER AGENCY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Contractor Use of Site and Premises.
- B. Utility and Building Services Outages and Shutdowns.
- C. Construction Requirements in Occupied Buildings.
- D. Construction Activities in Occupied Spaces.
- E. Time Restrictions and Working Hours.
- F. Schedule Coordination.

1.2 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Include in the Base Bid all costs of this coordination, including all premium time wages that may be required to meet these requirements and project schedule. Cost of all work done during second or third shifts or on weekends and holidays shall be included in the bid price. Contractor is responsible for protection and restoration of existing conditions including, but not limited to hardscape, landscape and lawns.
- B. Arrange use of site and premises to allow:
 - a. Adjacent projects to progress as planned for the User Agency.
 - b. Use of street and adjacent properties by the Public.
 - c. Continued operation of the facility.
- C. Provide access to and from site as required by law and by User Agency:
 - a. Maintain appropriate egress for workforce and users of the facility.
 - b. Do not obstruct roadways, sidewalks, or other public ways without permit. Provide necessary signage and barriers to direct pedestrians around work areas.
 - c. Barriers and signage must be provided by the contractor to the satisfaction of the User Agency to separate the work area from occupied areas. Efforts must be taken to limit dust, noise and odors from escaping the work area. Proper separation and protection of interior spaces shall be established and maintained during the project, to the satisfaction of the User Agency.
 - d. Contractor is responsible for cleaning construction dust and/or debris from public areas and daily or at the request of the User Agency. Work areas within the building shall be kept tidy at all times.
 - e. Maintain a safety buffer around the elementary school playground. Refer to the Site Utilization Plan.

1.3 UTILITY AND BUILDING SERVICES OUTAGES AND SHUTDOWN:

- A. Prevent accidental disruption of utility services to other facilities. Contractor is responsible for restoration and damages resulting from unplanned disruptions to utilities.
- B. For life safety systems interruptions or shutdowns, including but not limited to fire sprinklers and fire alarm system, seven (7) days' written notice to User Agency and authorities having jurisdiction shall be provided. Contractor to utilize Fire Sprinkler and Alarm System Impairment Notification Forms found in Section 00 73 02. Contractor is responsible for providing Fire Alarm Technician or support personal to provide the necessary bypassing or fire watch as required for fire sprinkler or other life safety shutdowns.
- C. Electrical, plumbing, network and other utility shutdowns shall be scheduled off hours. Contractor shall provide written request for utility shutdown at least 72 hours in advance.

- D. When construction activities impact ventilation, heating or air conditioning to occupied building spaces, the contractor shall provide the necessary equipment to maintain proper ventilation rates and a temperature of 68° heating and 72° cooling. Prior to the decommissioning of equipment, the contractor shall submit a plan for temporary HVAC services, including unit location, utility connection, ductwork tie in and other logistical considerations.
- E. Refer to Section 01 17 90 Utility Shutdowns for more information.

1.4 CONSTRUCTION REQUIREMENTS FOR OCCUPIED AREAS:

- A. The areas surrounding Horace Mann Hall will be occupied during construction. The Contractor shall be solely responsible for initiating, maintaining and supervising safety, security and protection programs and shall comply with all applicable laws, ordinances, rules and regulations concerning safety of people and the protection of property.
- B. Barriers and signage must be provided by the contractor to the satisfaction of the User Agency to separate the work area from occupied areas. Appropriate signage, approved by the User Agency, shall be placed at all potential entrances to the Project Site and maintained throughout the project.
- C. Efforts must be taken to limit dust, noise and odors from escaping the work area.
- D. The Contractor shall repair or replace, at his own expense, with new any item, surface, or object that is damaged by the Contractor or damaged because of the Contractor's actions during the course of the Work and during any guarantee period.
- E. Site and building conditions shall be restored to their condition as they were at the start of the Work. Before commencing work, the Contractor shall report any existing damage to the Architect in writing to assure that the Contractor will not be liable for preexisting damage.
- F. Contractor is responsible for cleaning construction dust and/or debris from public areas and daily or at the request of the User Agency. Work areas within the building shall be kept tidy at all times.
- G. Refer to Section 01 50 00 – TEMPORARY FACILITIES AND CONTROLS for more information.

1.5 CONSTRUCTION ACTIVITIES IN OCCUPIED SPACES

- A. It is not anticipated that work will need to take place in Interior Occupied Spaces, as the building will remain unoccupied during construction, however, any enabling work in Occupied Spaces will need to be coordinated with the Project manager per the notification requirements in paragraph C. This includes the work in Gaije Hall and Henry Barnard School for the telecommunications connections.
- B. Use of Exterior Occupied Spaces (not already designated in the site plan for site access) will be permitted during off-hours when written notification and communication is provided as required in paragraph C.
- C. Notification: Activities which require work in Exterior or Interior Occupied Spaces shall be specifically and clearly indicated on the Two-Week Look-Ahead. Written notification and coordination with the User Agency's Project Manager shall be provided at least seven (7) days in advance, including a plan indicating paths of travel, areas impacted and trades involved. This shall be confirmed with the User Agency at least two (2) business days in advance. Failure to provide notification as indicated may result in a postponement of the work; delays resulting from untimely notification shall be the responsibility of the Contractor.
- D. The safety of building occupants and construction workers is paramount. All construction activities within Occupied Spaces shall be marked with cones and caution tape. Computer generated signage shall be provided indicating the path of travel around construction zones, and shall also be posted at stairwell doors indicating where internal construction activities may take place.
- E. Sufficient time to clean up work zones shall be allocated at the end of the shift. All construction activities within the building shall be thoroughly vacuumed, wet mopped and cleaned to the satisfaction of the User Agency at the end of each shift.

- F. All construction materials, tools and debris must be removed from occupied spaces once construction activities have ended for the day. Occupied spaces must be returned to original conditions to the greatest extent possible by **8am weekdays**. If it is not feasible to do as such, notify the User Agency immediately. With approval, the area shall be cordoned off with cones and caution tape and computer generated signage shall be posted to the satisfaction of the User Agency.

1.6 **TIME** RESTRICTIONS AND WORKING HOURS

- A. Include in the Base Bid all costs of this coordination, including all premium time wages that may be required to meet these requirements and project schedule. Cost of all work done during second or third shifts or on weekends and holidays shall be included in the bid price.
- B. Disruptive Activities & Work Restrictions. The College uses the following categories to indicate work activities allowable during certain time periods:
- a. No Work: on site work is prohibited to take place during this time. Workers are prohibited from the site without prior notification to the User Agency. In order to ensure the safety of occupants and preserve the educational experience, work **MAY NOT** take place during the time periods specified in Paragraph C, below.
 - b. Quiet Work: vibration producing work may not occur. Work that generates noise or odors that would escape the project site and cause disruption to occupant in adjacent Occupied Spaces is prohibited. Disallowed activities include but are not limited to: demolition of block and concrete, use of jackhammers, saw cutting, hammer drilling, connecting to building structure, mechanical fastening and other work activities which provides loud noises or vibrations that are constant in nature. Use of heavy solvents, odious paints and other irritants which cannot be contained through mechanical or physical barriers prohibited. Work in Occupied Spaces prohibited unless specific, written authorization is requested and granted.
 - a. It is the sole discretion of the User Agency to determine if activities are considered disallowed during quiet work periods. The designation of disallowed activities is contingent on location within the job site and the activities of the occupants.
 - b. The contractor may request a "disturbance test" which may allow for some disallowed activities to take place during quiet work times. Contractor may request with 24 hour notice to run a limited test to determine if a specific activity in a set location can be performed during quiet work periods. The User Agency will observe the impact on the occupied areas and determine if the activity take place. Waivers resulting from disturbance tests will be valid for a set period of time, based on construction activities and occupant usage.
 - c. No Restrictions: normal construction activities may take place. No restrictions on noise or vibrations. Utility shutdowns may occur following proper notifications.
 - a. **This** project's unrestricted hours are 10pm-8am Sunday-Friday and weekends between 5pm Friday and 8am Monday.
 - b. There are not classes on the following days and therefore have no work restrictions:
- C. Working Hours
- a. Contractor is expected to plan and execute the work on schedule within the parameters indicated above. Regular working hours for contractors are between 7:00 a.m. and 4:00 p.m., Monday through Friday. Work that is to take place outside of these timeframes are to be reflected on the Two Week Look-Ahead.
 - b. Contractor is permitted to work holidays, nights and weekends if it is communicated two (2) business days in advance.

- c. In the event of adverse weather, the College is open unless a State of Emergency is called by the Governor. The College is not responsible for lost time due to weather. Contractor to communicate with Project Manager regarding the college's status.
- d. Special Work Hours are called for the following activities:
 - a. No Work Hours: inset per project.
 - b. Quiet Work: inset per project.
 - c. Hours of No Restrictions: inset per project.
 - d. Hoisting: inset per project.
 - e. Material deliveries: inset per project.

1.7 SCHEDULE COORDINATION

- A. The contractor shall provide, in writing, via email, by noon on Thursdays the two week project look ahead which lists in detail the planned activities, locations of disturbance, scheduled subcontractors and working hours for the forthcoming Sunday-Saturday. The same shall be provided for the second week, but as a working draft. The document shall list out any utility shutdowns or other activities which require review and approval of the User Agency. Failure to provide the Look Ahead may result in a reduction of payment of general requirements line item in the following pay requisition.

PART 2 - **PRODUCTS (NOT USED)**

PART 3 - **EXECUTION (NOT USED)**

END OF SECTION

01 17 90 – UTILITY PLANNING AND INTERRUPTIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section details the minimum coordination requirements for system connections and service interruptions that may be required for new construction and renovation projects.
- B. Requirements.
- C. Outage Types.
- D. Outage Planning.
- E. Outage Requirements.
- F. Scheduling.
- G. Outage Coordination

1.2 REQUIREMENTS

- A. If a project or contract work requires the shutdown or de-energizing of any campus utility or building system, Contractor shall notify, in writing, the User Agency's Project Manager at least ten (10) calendar days in advance of the planned outage. User Agency's Project Manager shall be responsible for contacting Facilities Operations and scheduling a meeting to review the shutdown. (Refer to Scheduling section).
- B. In general, Contractors are not allowed to operate valves open or closed, or energize and de-energize switches without prior coordination and approval from the User Agency. Exceptions to this policy are for new construction or within buildings that are closed for total renovation, where the utilities affected are within the construction zone and have been verified ahead of time not to have an adverse effect on other building or campus operations.
- C. Chilled water, high temperature hot water and steam shutdowns can be scheduled only during off-peak seasons with limited exceptions such as an emergency repair.
- D. Contractors shall coordinate to have the building fire alarm system disabled prior to performing any work, such as cutting or welding that may cause inadvertent operation of the fire alarm system, and arrange for it to be enabled at the completion of the work. The Contractor is responsible for costs related to and scheduling of their fire alarm subcontractor to support any alarm shutdown. The College will NOT provide the fire alarm technician.
- E. "Hot work" permits are required prior to any cutting and welding operations within buildings; follow all policy safety precautions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 OUTAGE TYPES

- A. There are three general types of outages, depending upon the impact that the work will have on existing building infrastructure and campus utilities. The level of planning and detail coordination required varies for each, as noted below.
 - a. Independent Outages:
 - a. Independent outages typically have no impact on existing campus utilities, operating communications infrastructure, building occupants or building systems. Examples include work

within new building construction or “gut” building renovations, or installation of new campus utilities not yet in service.

- b. For independent outages, the Contractor shall contact the User Agency’s Project Manager to coordinate the outage scheduling, as well as outage notification, to other College departments and building Users affected by this work. Facilities Operations support is not required for this type of outage.
- b. Minor Outages:
 - a. Minor outages typically have a limited impact on existing campus utilities, including operating communications infrastructure within the project site or running through the site; building occupants or building systems. Examples include fire alarm zone lock-outs for welding or other “Hot work” permits, to suit the installation of new fire alarm devices, or for branch line water shut-offs to suit connections of new plumbing fixtures.
 - b. For Minor outages, limited College coordination is required; the Contractor shall contact the User Agency’s Project Manager to coordinate the outage scheduling with Facilities Operations and the College’s trade staff. Details of the outage work will be developed as a general scope of work.
 - c. Project Manager will also coordinate the outage notification to other College departments and building Users affected by this work. Minimum outage notification times are required and an outage coordination meeting prior to the outage is required to review outage scope and details (See Scheduling section).
- c. Major Outages:
 - a. Major outages typically have a significant impact on existing campus utilities, communication systems and infrastructure, building occupants or building systems. Examples include shut down of building electrical power systems, central heating and cooling systems, shutdown of BAS and fire alarm systems, or shutdown of campus water, heating and chilled water systems.
 - b. For Major outages, significant coordination is required for both the Contractor and the User Agency. Determination of major outages will be made in the Project Planning phase. Details of the outage work, and general outage scheduling will be developed during the design phase as an outage checklist (OCL).
 - c. During the construction phase, Contractor shall coordinate outage scheduling with the User Agency’s Project Manager who will contact Facilities Operations to coordinate the required to support the outage work, as well as develop work orders for Trades support.
 - d. User Agency’s Project Manager will also coordinate the outage notification to other College departments and building Users affected by this work. Minimum outage notification times are required and an outage coordination meeting prior to the outage is required to review outage scope and details (See Scheduling section).

3.2 OUTAGE PLANNING

- A. The Contractor will utilize the Utility & Critical System Outage Checklist deliverables provided in the Design phase and incorporate all required outages into their project construction schedule as milestone activities.
- B. The Contractor shall utilize and update the draft Utility & Critical System Outage Checklist(s) (OCLs) (as developed by the Design Agent) based on their proposed project schedule and plan for construction.
- C. The updated Utility & Critical System Outage checklist shall be used for required outage coordination review meetings to review and confirm the outage impacts and resources required to support the outage from the College, the project team or others. Updated outage checklists shall clearly identify:
 - a. Project impacts (what buildings, utility systems and/or system loads are impacted by the work).
 - b. Any updates determined in the course of Contractor’s physical walkdown and verification of what systems and equipment are affected by the proposed shutdown.

- c. Outage schedule (time/date of when work will be performed and outage durations), including contingency communications for work that will extend beyond schedule;
 - d. Required prep work to be completed or to be in place prior to support the actual outage work (install portable generator(s), pipe flushing procedures, filling and venting procedures, etc.).
 - e. Brief description of the actual outage work and essential tasks being performed during the outage (Switches or valves being opened/closed, piping connections, etc.);
 - f. Note key coordination issues that need to be included as a part of the outage (need for portable generators to maintain power, street closure(s), police details, etc.).
 - g. For hydronic systems, include how system draining, flushing, refilling and venting will be accomplished.
 - h. For building electrical system outages, include copies of the panelboard schedules for all affected electrical equipment (panelboards, switchboards, motor control centers, etc.).
 - i. Review and identify any potential outage impacts that may affect ongoing critical Research and Academic activities: i.e.: campus water and/or electrical services; building ventilation and exhaust systems, BAS controls, etc.
 - j. Listing of key contacts and phone numbers for the Contractor, Facilities Operations, Information Technology Services (ITS) DPS staff, and affected building staff.
- D. As a prerequisite of outage planning and preparations, it is the responsibility of the Contractor to perform their own visual inspection and walk down to verify what utilities and systems will be physically affected by the shutdown. This effort shall be made after review of available Record documentation, and consultations with the Design Agent, User Agency's Project Manager and Facilities Operations, as well as other affected College departments, such as Environmental Health & Safety, Informational Technology, etc. The intent of the physical inspection and walkdown is to:
- a. Verify known systems and system loads that will be affected by the outage.
 - b. Identify any other undocumented systems and loads that may be affected by the proposed outage.
 - c. Verify locations of existing system isolation switches, valves, bypasses, and temporary services.

3.3 OUTAGE REQUIREMENTS

- A. Facilities Operations shall be notified for all interruptions that affect building fire alarm and detection systems, fire suppression systems (fire sprinklers, kitchen hood suppression systems, dry systems, clean agent or Halon suppression systems), fire pumps and water distribution lines that connect to fire suppression systems.
- B. For Research facilities, Facilities Operations shall be notified of all interruptions affecting: fume hoods, HVAC supply and exhaust systems, Potable and non-Potable water systems, electrical, heating and cooling systems and Process cooling systems.
- C. The College's Information Technology Services (ITS) office requires notification for all communications systems and infrastructure outages and interruptions that affect telephone or network services.
- D. Proper Lockout/Tagout procedures shall be followed by both the Contractor and College's staff.

3.4 SCHEDULING

- A. Outage dates shall be coordinated with the College's Academic calendar and identified blackout (no outage work) periods. Outages will occur off hours unless otherwise approved by the User Agency.
- B. Independent Outages: Per the User Agency's discretion.
- C. Minor Outages: normal workday hours; 48-hour minimum advance notice. Weekend/off-hours; 72-hour minimum advance notice. Actual outage scheduling is subject to User Agency's staff availability.

- D. Major Outages: As determined by draft Utility & Critical System Outage checklist: minimum (2) week notice after approval; (4) weeks is preferred for major shutdowns.
- E. The User Agency's Project Manager will assist the Constructor in the scheduling, as well as the notification of, related building Users and other College departments affected by this work.
- F. Steam Shutdowns must be coordinated through the Project Manager. Facilities Management will perform all steam shutdowns. The contractor must provide a minimum of ten (10) calendar days' notice to the Project Manager for a pre-scheduled shutdown. The pre-scheduling must take place as far in advance as practicable, and no later than 30 days in advance.

3.5 OUTAGE COORDINATION

- A. The Project Manager shall coordinate the shutdown details required for the project with the Facilities and Operations staff, the project team, Campus Police, and the Building Users (as required by the particular system interruption).
- B. A coordination meeting shall be held with representatives of the Contractor, affected building Users, and other concerned parties to review the planned outage sequences and timing. Facilities Operations staff will generally advise of what campus operations and building Users will be affected by the proposed outage or shutdown; the Project Manager is in turn responsible to contact all the affected groups to determine the proper time for the shutdown and any special requirements to be provided during the shutdown.
- C. A Utility and Critical System Outage Checklist (OCL) is required to be filled out for each major outage by the Design Agent and Contractor, with support from the Project Manager. The checklist includes relevant pre-outage work required prior to the outage, sequence(s) of work to be performed during the outage, expected outage times and durations, and key contact (cell phone) information for the Contractor, Facilities Operations staff, other affected College Department staff and affected Users. The completed checklist requires sign-off from the Facilities Operations Director.
- D. The Project Manager will submit the signed outage checklist to Facilities Operations, who will then assign to the appropriate staff to perform and monitor the shutdown. The Project Manager will also formally notify all affected parties of the planned outage date(s) by e-mail and physical posting of the impacted buildings.

END OF SECTION

01 20 00 – PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Sales tax exemption.
- B. Allowances.
- C. Testing and inspection allowance.
- D. Unit prices.
- E. Alternates.
- F. Schedule of values.
- G. Applications for payment.
- H. Change procedures.
- I. Defect assessment.
- J. Warranty inspection retainage.
- K. Waiver of Lien Form
- L. MBE Compliance Form

1.2 TAX EXEMPTION

- A. The State of Rhode Island is exempt from payment of any federal or state excise, transportation, or sales tax. Refer to A201-2007 General Conditions §3.6.2.
 - a. Place exemption certificate number on invoice for materials incorporated in the Work of the Project.
 - b. Furnish copies of invoices to Owner.
 - c. Upon completion of Work, file a notarized statement with Owner that all purchases made under exemption certificate were entitled to be exempt.
 - d. Pay legally assessed penalties for improper use of exemption certificate number.

1.3 ALLOWANCES

- A. Refer to A201-2007 §3.8 for Allowance provisions. General Contractor overhead and profit, bonding and other fees should be calculated into the Contract Sum and may not be assessed on Allowance Usage.
- B. Design Agent Responsibility:
 - a. Consult with Contractor for consideration and selection of products, suppliers, and Installers.
 - b. Select products in consultation with User Agency and transmit decision to Contractor.
 - c. Prepare Change Order to account for the use of allowance.
- C. Contractor Responsibility:
 - a. Assist Design Agent or its Consultants in selection of products, suppliers and installers.

- b. Obtain proposals from suppliers and installers, and offer recommendations.
 - c. On notification on selection by Design Agent, execute purchase agreement with designated supplier and installer.
 - d. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
 - e. Modify the Schedule of Values to provide line items for each approved use of an allowance.
 - f. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.
- D. Schedule of Allowances: Allowances
- a. Please refer to the Bid Form for the list of Allowances.

1.4 TESTING AND INSPECTION ALLOWANCE

- A. All costs of regularly scheduled testing are included in the Base Bid. See Bid Form for allowance to cover costs of additional testing to be provided when directed by the User Agency.
- B. See Section 01 40 00 and its attachment for testing requirements.

1.5 UNIT PRICES

- A. See Section 01 22 00.

1.6 ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the User Agency's option. Accepted Alternates will be identified in the Purchase Order.
- B. Coordinate related work and modify surrounding work as required.
- C. Schedule of Alternates: See Section 01 23 00.

1.7 SCHEDULE OF VALUES

- A. Refer to A201-2007 General Conditions §9.2 for Schedule of Values provisions. Contractors are encouraged to submit the Schedule of Values as soon as practical after contract commencement, but within the duration indicated in the General Conditions.
- B. Schedule of Values (SOV) shall only be accepted on an original AIA Form G702 - Application and Certificate for Payment and AIA G703 - Continuation Sheet.
- C. Format:
 - a. Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the major specification Section.
 - b. At a minimum, provide line items under the heading General Conditions for: Site Mobilization, Bonds, Insurance, Permits, Construction Schedules, Temporary Facilities, Project Management & Supervision, General Cleaning, and Dumpsters & Trash Removal. The Design Agent and User Agency reserves the right to request further breakout beyond those requested here.
 - c. At a minimum, provide line items under the heading Closeout for: Final Cleaning, Monetized Punchlist (zero value at start of contract), Administrative Closeout, Owner's Manual, Project Record Documents and Warranty Retainage (.5%). The Design Agent and User Agency reserves the right to request further breakout beyond those requested here.

- d. Per A101-2017 §5.5, out of state firms shall also include a "Foreign Company" line item valued at 3% of the Contract Sum.
 - e. Provide separate line items for Labor and Materials where the value is greater than \$10,000.
 - f. Provide separate line items where multiple vendors or subcontractors are providing services.
 - g. No single line item shall exceed twenty percent (20%) of the total contract.
 - h. Identify each Allowance as a line item.
 - i. Identify each Alternate as a line item.
- D. Submit for review and approval to the Design Agent and User Agency the Schedule of Values prior to the first Application for Payment. Indicate in the email the intended date for each progress payment, typically the last day of the month. The first Application for Payment will not be accepted until the SOV is approved.
- E. Revisions:
- a. Once approved, the SOV shall only be revised to accommodate changes to the Contract Value.
 - b. Revise SOV to list changes to the contract value for which a revised Purchase Order has been issued. Provide a heading for the Change Order Number and list Change Order Proposals comprising said Change Order as individual lines on the SOV.
 - c. As Allowances are used, under the heading for the appropriate allowance, list Change Order Proposals charged to the Allowance as individual lines on the SOV. For unit cost Allowances, identify quantities taken from Contract Documents multiplied by the unit cost to achieve the total for the item.

1.8 APPLICATIONS FOR PAYMENT

- A. See General Conditions §9.3 for Applications for Payment provisions. Contractors shall submit for payment on a monthly basis.
- B. Prepare a draft version "pencil copy" of each application.
- a. The Pencil Copy shall be distributed via email ten (10) calendar days prior to the established date for progress payment for review by Design Agent and User Agency's representative.
 - b. Accompanying the Pencil Copy, Contractor shall provide a summary list of all sub-contractors who performed work on the site for the month.
 - c. Design Agent and User Agency's representative shall review the Pencil Copy and request adjustments as appropriate.
 - d. Contractor shall make agreed revisions and prepare final for payment
- C. Submitting for Payment
- a. Prepare one (1) original of the approved AIA Form G702 - Application and Certificate for Payment and AIA G703 - Continuation Sheet, accompanied by three (3) copies.
 - b. Individually sign and notarize and emboss with notary's official seal, the original and each of the three (3) copies. Deliver to Design Agent for further processing and distribution.
 - c. Applications not including original copyrighted AIA G702, and G703 Forms, will be rejected, and returned for re-submittal.
 - d. Applications not properly signed and notarized will be rejected, and returned for re-submittal.

- D. An Application for Payment is not considered acceptable per the Prompt Payment Policy until the signed, notarized and certified AIA G702 and G703 Forms with ALL required enclosures are received. Applications submitted without the following items described in this section and its attachments will be returned for resubmittal. These items shall be sent via email to the User Agency's Representative. Failure to provide items listed below with the Application for Payment submission will result in a delay in processing and may result in a reduction in the amount of said Application for Payment.
- a. Transmittal letter as specified for Submittals in Section 01 33 00.
 - b. Updated construction schedule, prepared per Section 01 33 00.
 - c. Statement signed by the Contractor's firm principal certifying that there are no unidentified outstanding claims for delay.
 - d. Beginning with the second Application for Payment, Certified Monthly Payroll Records for all workers on site for the previous month.
 - a. Forms for the submission of Certified Payroll Records may be found from the Rhode Island [Prevailing Wage Website](#) in either PDF or Excel formats. These forms must be used on monthly submittals.
 - e. Beginning with the second Application for Payment, Contractor's right to payment must be substantiated by documenting, on a copy of the RIC Waiver of Lien Form included in this Project Manual, that payment monies due, less retainage not exceeding five (5) percent, have been paid in full to subcontractor and suppliers for work, materials, or rental of equipment billed for under specific line item numbers in the immediately preceding application.
 - f. Affidavits attesting to off-site stored products with insurance certificates as requested.
 - g. Digital Photographs as specified in Section 01 33 00. Provide as a link.
 - h. Updated Submittal Log.
 - i. Identify Apprenticeship hours required under RIGL 37-13-3.1 for all contracts over \$1million in value.
 - j. A Minority Utilization Report for minority subcontractors must be included. Use the form provided.
 - k. Additional Substantiating Data: When the User Agency or Design Agent requires additional substantiating information from the review of the "pencil copy," submit data justifying dollar amounts in question.

1.9 CHANGE PROCEDURES

- A. Refer to AIA A201-2007 General Conditions §7.
- B. Submittals: Submit name of the individual authorized to receive change documents and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.
- C. Types of Change Proposals
 - a. Stipulated Sum Change Order: Based on Proposal Request and Contractor's Change Proposal as approved by Design Agent. All quotations shall include detailed material costs and labor hour and rate breakouts.
 - b. Unit Price Change Order: For contract unit prices and quantities, the Change Order will be executed on a fixed unit price basis. For unit costs or quantities of units of work which are not pre-determined, execute the Work under a Construction Change Directive. Changes in the Contract Sum or Contract Time will be computed as specified for a Time and Material Change Order.

- c. Time and Material Change Order: Submit an itemized account and supporting data after completion of the change, including timeslips signed by User Agency's representative, within the time limits indicated in the Conditions of the Contract. The Design Agent will determine the change allowable in the Contract Sum and Contract Time as provided in the Contract Documents. Only User Agency-representative-signed timeslips will be considered.
- D. The Design Agent may issue a Proposal Request which includes a detailed description of a proposed change with supplementary or revised Drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required, and the period of time during which the requested price will be considered valid. Contractor will prepare and submit the Change Proposal within fifteen (15) calendar days.
- E. The Contractor may propose changes by submitting a Change Proposal request to the Design Agent and User Agency, describing the proposed change and its full effect on the Work. Include a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation, and a statement describing the effect on Work by separate or other Contractors. Document any requested substitutions in accordance with Section 01 60 00.
- F. For all Change Proposals, maintain detailed records of work done on a Time and Material basis. Submit timeslips daily for verification and sign-off by User Agency's representative on-site. Provide full information required for an evaluation of the proposed changes, and to substantiate costs for the changes in the Work.
- G. Document each quotation for a change in cost or time with sufficient data to allow an evaluation of the quotation. Provide detailed breakdown of costs and estimates for labor and materials including a detailed breakdown for subcontractor's or vendor's Work. Include copies of written quotations from subcontractors or vendors.
- H. Construction Change Directive: refer to General Conditions §7.3. Design Agent may issue a directive, on AIA Form G713.
- I. For Minor Changes, §7.4: The Design Agent will advise of minor changes in the Work not involving an adjustment to Contract Sum or Contract Time by issuing supplemental instructions on AIA Form G710.
- J. Change Order Forms: AIA G701 Change Order.
- K. Execution of Change Orders: The Design Agent will issue Change Orders for signatures of the parties as provided in the Conditions of the Contract. Electronic signatures are acceptable. Design Agent shall also issue a Letter of Justification to accompany the Change Order.
 - a. The approved Change Order amount shall include all compensation to the Contractor, including but not limited to Overhead and Profit, General Conditions, Material, Labor, Equipment and other costs. Following the execution of the Change Order, no additional compensation for the work covered in the Change Order shall be considered.
- L. Correlation Of Contractor Submittals:
 - a. Promptly revise the Schedule of Values and the Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum. Promptly revise progress schedules to reflect any change in the Contract Time, revise sub-schedules to adjust times for any other items of work affected by the change, and resubmit.
 - b. Promptly enter changes in the Project Record Documents.
 - c. Update Schedule of Values and Subcontractor List as required.

1.10 DEFECT ASSESSMENT

- A. Refer to General Conditions §12.2. Replace the Work, or portions of the Work, not conforming to specified requirements.
- B. If, in the opinion of the Design Agent, it is not practical to remove and replace the Work, the Design Agent will direct an appropriate remedy or adjust payment.
- C. The defective Work may remain, but the unit sum will be adjusted to a new sum at the discretion of the Design Agent.
- D. The defective Work will be partially repaired to the instructions of the Design Agent, and the unit sum will be adjusted to a new sum at the discretion of the Design Agent.

1.11 WARRANTY INSPECTION RETAINAGE

- A. One-half of one percent of the cost of the Work will be retained from Final Payment for duration of twelve (12) months from date of Substantial Completion. This shall be included in the Schedule of Values. If, after ten months, all systems including mechanical and electrical, are determined by the User Agency to be properly functioning, the Warranty Inspection Retainage will be released.
- B. If, after twelve (12) months, there are found to be modifications, adjustments, or corrections necessary to be made to address any system or product malfunction, in order to fulfill specified performance or requirements of such systems or products, release of the warranty inspection retainage will be delayed until such malfunctions are rectified.
- C. If, after twelve (12) months from the date of Substantial Completion, all systems have not been fully addressed, the User Agency may utilize the Warranty Inspection Retainage to hire others to execute necessary modifications, adjustments, or corrections.

1.12 WAIVER OF LIEN FORM

- A. RIC Document Waiver of Lien Form is included, following this page, as an integral part of the Contract documents. A copy with completed information must be submitted with the second and each succeeding Application for Payment.

1.13 MBE COMPLIANCE

- A. The MBE Compliance Form is included after this section. Contractors shall work with the RI Office of Diversity, Equity & Opportunity to ensure that all participation and reporting requirements are met.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION



**RHODE
ISLAND
COLLEGE**

Capital Projects Administration
600 Mount Pleasant Ave, Welcome Center Suite 300, Providence, RI 02908

WAIVER OF LIEN FORM MATERIAL OR LABOR

Construction Project Title: _____

General Contractor: _____

Subcontractor/Supplier: _____

DUNS No.: _____

Application / Certificate for
Payment No.: _____

Paid Through Date: _____

Schedule of Values Line Item
No.: _____

Description of Work Heading: _____

Total Payments Received,
Including Current Payment: _____

The undersigned Representative of the above Subcontractor/Supplier has been contracted by the above General Contractor to furnish materials, or labor, or both, as included in the approved Schedule of Values under the Line Item No. and Description of Work Heading indicated above, for the Construction Project listed above.

The undersigned acknowledges receipt of payment, under this Line Item No. and Description of Work Heading, and hereby waives and releases any and all lien, or claim or right to lien, on the Construction Project listed above, and premises, under the statutes of the State of Rhode Island, relating to Mechanics Liens, on account of materials, or labor, or both, furnished, or which may be furnished, by the undersigned to, or on account of, the above numbered Application and Certificate for Payment.

Dated at this ____ day of _____, 20__

Company: _____

Signature: _____

Printed Name: _____

Title: _____

END OF ATTACHMENT

Office of Diversity, Equity and Opportunity (ODEO)
MBE Compliance Office
1 Capitol Hill, 3rd Floor
Providence, RI 02908

(401) 574-8670
<http://odeo.ri.gov/>

Pursuant to RIGL 37-14.1 as well as the regulations promulgated thereto, the MBE Compliance Office requires that you complete the following table. Please note that these figures will be verified with the MBEs identified. If there are outstanding issues, such as retainage or a dispute, please indicate and attach supporting documentation for same. Also note that copies of invoice and cancelled checks for payment to all MBE subcontractors and suppliers are required.

Contractor/Vendor Name: _____ **Current Prime Contract Amount:** \$ _____ **% Complete:** _____
Project Name & Location: _____
Original Prime Contract Amount: \$ _____

MBE/WBE Subcontractor	Original Contract Amount	Change Orders	Revised Contract Value	% Completed To Date	Amount Paid To Date	Amount Due	Retainage %	Retainage Amount	Explanation

I declare, under penalty of perjury, that the information provided in this verification form and supporting documents is true and correct.

Signature _____ Date _____

Printed Name
Notary Certificate:

Sworn before me this _____ day of _____, 20____.

Notary Signature _____ Commission Expires _____

01 23 00 ALTERNATES

PART 1 GENERAL

3.1 SECTION INCLUDES

- A. Description of alternates.

3.2 ACCEPTANCE OF ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at User Agency's option. Accepted alternates will be identified in the Contract Documents.
- B. Coordinate related work and modify surrounding work to integrate the Work of each alternate.

3.3 SCHEDULE OF ALTERNATES

- A. Alternates are indicated in the Drawings and Specifications.
- B. Refer to the Bid Form for the grouping of the Alternates for pricing purposes. Please note the Bid Form Alternate Lists may purposefully exclude individual Alternates identified on the drawings.

PRODUCTS (NOT USED)

PART 4 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 13 – REQUESTS FOR INFORMATION**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Procedures for submitting a Request for Information (RFI).
 - 2. Limitations on use of RFI to obtain interpretation and clarification.
- B. Related Requirements:
 - 1. Section 01 25 00 - Substitution Procedures: Procedures for requesting substitutions of materials, products, equipment and systems.
 - 2. Section 01 31 00 – Project Management and Coordination: Requirements for organizing and coordinating the Work.
 - 3. Section 01 33 00 - Submittals Procedures: Restriction on use of submittals for changes in materials, products, equipment and systems.

1.3 DEFINITIONS

- A. RFI: Request for Information. A document submitted by the Contractor requesting information required by or clarifications of the Contract Documents, due to a conflict in the Contract Documents and/or an unforeseeable field condition.
- B. Nonconforming RFI: An RFI not prepared in accordance with the Contract Documents.
- C. Frivolous RFI: An RFI that requests information readily available from a careful study and comparison of the Contract Documents, field conditions, other Owner-provided information, contractor prepared coordination drawings, or prior Project correspondence or documentation.

1.4 SUBMITTALS

- A. Informational Submittals
 - 1. RFI log – Submit weekly in PDF format.
- B. Action Submittals
 - 1. Blank RFI or Example RFI to illustrate that the submitted form will include required content.

1.5 RFI FORMAT AND CONTENT

- A. Content of the RFI: Include a detailed, legible description of the conflict, the item needing information or interpretation and the following:

1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor, and subcontractor(s) authoring request.
 5. Name of Architect.
 6. RFI number, numbered sequentially.
 - a. The first RFI will be RFI #001-01. Follow-up RFIs will be #001-02, #001-03 etc...
 - b. The second RFI will be #002-01.
 7. RFI subject.
 8. Drawing number and detail references, as appropriate.
 9. Specification Section number and title and related paragraphs, as appropriate.
 10. Include other information necessary to fully describe items needing interpretation, not limited to the following:
 - a. Annotated contract details.
 - b. Sketches that include measurements and/or field dimensions, and conditions.
 - 1) Include dimensions, thicknesses, and structural grid references.
 - 2) Include details of affected materials, assemblies, and attachments.
 - c. Photographs.
 - d. Product Data.
 - e. Shop Drawings, and/or Coordination Drawings.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's priority ranking of request as coordinated with Construction Schedule: High Importance, Medium Importance or Low Importance.
 13. Contractor's signature.
- B. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in Adobe Acrobat PDF format; one (1) PDF with multiple pages should be submitted, instead of multiple PDF files.
- 1.6 RFI LOG
- A. Contractor shall prepare, maintain, and submit a tabular log of RFIs organized by the RFI number.
- B. The RFI Log shall include the following information:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
 8. Architect's Response.
 9. Drawing Reference or Specification Section to which the request pertains.
- 1.7 RFI PROCEDURE
- A. Identifying need for an RFI: Should Contractor be unable to determine from the Contract Documents 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 the Contract Documents; the Contractor shall request that the Architect make an interpretation of the requirements of the Contract Documents to resolve such matters.

- B. Contractor's Request: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's Work, or Work of subcontractors.
 2. Contractor will prepare each RFI, and confirm it includes the required content.
 3. Contractor shall sign all RFIs attesting to good faith effort to determine from the Contract Documents the information requested for interpretation. Frivolous RFIs shall be subject to reimbursement from Contractor to Owner for fees charged by Architect, Architect's consultants and other design professionals engaged by the Owner.
 4. Contractor shall distribute the RFI to the Architect and Owner, in a manner acceptable to the Architect.
 5. Allow fourteen (14) calendar days for Architect's response for each RFI.
 6. RFIs received by Architect after 1:00 p.m. will be considered received the following working day.
- C. Subcontractor-Initiated and Supplier-Initiated RFIs: RFIs from subcontractors and material suppliers shall be submitted through, be reviewed by and be attached to an RFI prepared, signed and submitted by Contractor. RFIs submitted directly by subcontractors or material suppliers will be returned unanswered to the Contractor.
1. Contractor shall review all subcontractor- and supplier-initiated RFIs and take actions to resolve issues of coordination, sequencing and layout of the Work.
 2. RFIs submitted to request clarification of issues related to means, methods, techniques and sequences of construction or for establishing trade jurisdictions and scopes of subcontracts will be returned without interpretation. Such issues are solely the Contractor's responsibility.
 3. Contractor shall be responsible for delays resulting from the necessity to resubmit an RFI due to insufficient or incorrect information presented in an RFI.
- D. Architect's Action: Architect will review each RFI, determine any action required, and respond as necessary.
1. Architect will return without action those RFIs submitted to Architect by other entities controlled by Contractor.
 2. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 3. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
- E. Contractor's Action:
1. On receipt of Architect's action, update the contractor's RFI log.

2. On receipt of Architect's RFI response, immediately distribute the RFI response to contractor responsible parties.
3. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within seven (7) calendar days of receipt of the RFI response.
 - a. Architect RFI responses which necessitate a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit a Change Proposal according to Section 01 26 00 "Contract Modification Procedures."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 26 13

01 30 00 – ADMINISTRATIVE REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pre-Award Meeting.
- B. Site Administration.
- C. Coordination and Project Conditions.
- D. Preconstruction Meeting.
- E. Site Utilization Plan.
- F. Preconstruction Video.
- G. Site Mobilization Meeting.
- H. Progress Meetings.
- I. Digital Photographs of Progress.
- J. Pre-installation Meetings.

1.2 PRE-AWARD MEETING

- A. Following the issuance of the Notice of Tentative Award from the RI State Purchasing Office, the Design Team, User Agency and Contractor shall convene as soon as possible for a Pre-Award Meeting.
- B. The Architect shall prepare meeting minutes and provide to the User Agency in Microsoft Word format within two (2) business days of the meeting. The User Agency shall review and make edits as required and transmit to the Contractor for review and acceptance. Upon the receipt of an email indicating the Contractor's acceptance of the minutes, the User Agency shall prepare the AIA Contract and General Conditions.
- C. Agenda
 - a. Introductions.
 - b. Roles, responsibilities and lines of communications.
 - c. Site utilization expectations.
 - d. Anticipated schedule.
 - e. Thorough Scope Review, using form generated by the User Agency and Design Agent. Form shall become part of the Contract Documents.
 - f. Discussion of inspections, testing, verification and commissioning.
 - g. Review of pre-award and post-contract documents, deliverables and requirements.

1.3 SITE ADMINISTRATION

- A. Maintain a daily attendance log to include the names of all project employees and guests to the site. Each guest signing the log should indicate a brief description of the reason for the visit, the guest's employer or organization. The log sheet, or sheets, must clearly indicate the Project Name, and the name of the general Contractor. Each line in the log should allow for the name of that employee, the employee's job title (use terminology used by prevailing wage job title), and the name of that employee's employer. This log shall be kept on a uniform form prescribed by the Director of Labor and Training. Such log shall be available for inspection on the site at all times by the Purchaser, Owner, User Agency,

and/or the Director of the Department of Labor and Training and his or her designee. Provide copies when requested.

- B. Daily Attendance Form
 - a. Maintain Daily Attendance Form acceptable to the Department of Labor and Training for all projects with a contract value over \$1 Million. Submit as requested.

1.4 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate the scheduling, submittals, and the Work of the various Sections of the Project Manual to ensure an efficient and orderly sequence of the installation of interdependent construction elements.
- B. Verify that the utility requirements and characteristics of the operating equipment are compatible with the building utilities. Coordinate the Work of the various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate the space requirements, supports and installation of the mechanical and electrical Work, which are indicated diagrammatically on the Drawings. Follow the routing shown for the pipes, ducts, and conduit, as closely as practicable; place runs parallel with the lines of the building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. Coordinate the completion and cleanup of the Work of the separate Sections in preparation for Substantial Completion and for portions of the Work designated for the User Agency's partial occupancy.
- E. After the User Agency's occupancy of the premises, coordinate access to the site for correction of defective Work and the Work not in accordance with the Contract Documents to minimize disruption of the User Agency's activities.
- F. The contractor shall provide MEP/FP coordination drawings with all systems overlaid into a single digital file.

1.5 PRECONSTRUCTION MEETING

- A. The Design Agent will schedule a meeting after a Purchase Order is issued to the Contractor.
- B. Attendance Required: User Agency's Representative, Design Agent, and Contractor.
- C. Agenda:
 - a. Distribution of the Contract Documents.
 - b. Review of submission of contractually required deliverables: Superintendent Qualifications, procurement timeline and list of Subcontractors, list of products, submittal log with timelines, schedule of values, project schedule, site safety procedures and mobilization schedule.
 - c. Designation of the personnel representing the parties in the Contract and the Design Agent.
 - d. The procedures and processing of requests for information, site access, field decisions, submittals, substitutions, applications for payments, proposal requests, Change Orders, and Contract closeout procedures.
 - e. Scheduling.
 - f. Establish communication protocol
 - g. Protocol for web-based file management
- D. The Design Agent shall record the minutes and distribute copies within two (2) days of the meeting to the participants, with copies to the Contractor, User Agency, other participants, and those consultants affected by the decisions made.

1.6 SITE UTILIZATION PLAN

- A. Refer to Section 01 50 00 Temporary Facilities and Controls for specific requirements.
- B. A Site Utilization Plan shall be submitted by the Contractor within ten (10) business days of issuance of the Purchase Order for approval by the User Agency.

1.7 PRECONSTRUCTION VIDEO

- A. Conduct a pre-construction survey of the project side and areas immediately adjacent to the site. Submit two (2) copies of the video on DVD to the User Agency.

1.8 SITE MOBILIZATION MEETING

- A. The Design Agent will schedule a meeting at the Project site prior to the Contractor's occupancy and may occur at the same time as the Preconstruction meeting noted above.
- B. Attendance Required: The User Agency, Design Agent, Contractor, the Contractor's Superintendent, and major Subcontractors.
- C. Agenda:
 - a. Use of the premises by the User Agency and the Contractor. / Review Site Utilization Plan.
 - b. The User Agency's requirements and partial occupancy.
 - c. Construction facilities and controls provided by the User Agency.
 - d. Temporary utilities provided by the User Agency.
 - e. Security and housekeeping procedures.
 - f. Schedules.
 - g. Application for payment procedures.
 - h. Procedures for testing.
 - i. Procedures for maintaining the record documents.
 - j. Requirements for the start-up of equipment.
 - k. Inspection and acceptance of the equipment put into service during the construction period.
- D. Contractor shall record the minutes and distribute the copies within two days after the meeting to the participants, with copies to the Design Agent, User Agency, other participants, and those consultants affected by the decisions made.

1.9 PROGRESS MEETINGS

- A. Schedule and administer the meetings throughout the progress of the Work at weekly intervals while work is in process.
- B. Make arrangements for the meetings, prepare the agenda with copies for the participants, and preside at the meetings.
- C. Attendance Required: The job superintendent, major subcontractors and suppliers, the User Agency, Design Agent, and Consultants as appropriate to agenda topics for each meeting.
- D. Agenda:
 - a. Review the minutes of previous meetings.
 - b. Review of the Work progress.
 - c. Field observations, problems, and decisions.
 - d. Identification of the problems which impede the planned progress. The contractor shall maintain a "Hot List" to manage

- e. Review of the submittals schedule and status of the submittals.
 - f. Review of delivery schedules.
 - g. Maintenance of the progress schedule.
 - h. Corrective measures to regain the projected schedules.
 - i. Planned progress during the succeeding work period.
 - j. Coordination of the projected progress.
 - k. Maintenance of the quality and work standards.
 - l. Effect of the proposed changes on the progress schedule and coordination.
 - m. Other business relating to the Work.
- E. Contractor shall record the minutes and distribute the copies within two days after the meeting to the participants, with copies to the Design Agent, Consultants, User Agency, participants, and others affected by the decisions made.

1.10 DIGITAL PHOTOGRAPHS OF WORK PROGRESS

- A. Submit minimum 12 digital photographs of construction progress each month. Include both jpg. and reduced-size pdf versions for email use. Refer to Price and Payment Procedures 01 20 00
- B. Include an additional minimum of 12 photographs documenting underground utilities when installed in relationship to visible site features.
- C. Include photographs of important in-wall or ceiling utilities before close-in at appropriate stages of construction.
- D. See Section 01 78 00 for close-out copy requirements of these files.

1.11 PREINSTALLATION MEETINGS

- A. When required in the individual specification Sections or listed below, convene a pre-installation meeting at the site prior to commencing the Work of the Section. Pre-installation Meetings:
 - a. The following items of work will require pre-installation meetings:
 - a. Temporary HVAC systems
 - b. Network and Telecommunication wiring and systems.
 - c. Network and Telecommunication data rack connections.
 - d. Fire Alarm and Sprinkler demolition and installation.
 - e. Door Access and Security Systems
 - f. Refer to the individual specification sections.
- B. Require attendance of the parties directly affecting, or affected by, the Work of the specific Section.
- C. Notify the Design Agent four days in advance of the meeting date.
- D. Prepare an agenda and preside at the meeting:
 - a. Review the conditions of installation, preparation and installation procedures.
 - b. Review coordination with the related work.
- E. Record the minutes and distribute the copies within two days after the meeting to the participants, with copies to the Design Agent, User Agency, participants, and those Consultants affected by the decisions made.

PART 2 - PRODUCTS (NOT USED)

LLB ARCHITECTS
AUGUST 30, 2024

RHODE ISLAND COLLEGE
RIC CYBER COMMAND CENTER – ALGER HALL
CONSTRUCTION DOCUMENTS

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 33 00 – SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Submittal procedures.
- B. Site superintendent.
- C. Construction progress schedules.
- D. Subcontractor list.
- E. Proposed products list.
- F. Product data.
- G. Shop drawings.
- H. Samples.
- I. Test reports.
- J. Design Data.
- K. Certificates.
- L. Manufacturer's instructions.
- M. Manufacturer's field reports.
- N. Erection drawings.

1.2 SUBMITTAL PROCEDURES

- A. Per General Conditions §3.10.2, a Submittal Schedule (Log) shall be submitted. To ensure timely execution of the work, Contractor is encouraged to submit the Submittal Schedule for review within seven (7) calendar days of issuance of the Purchase Order. The Submittal Log shall list all required submittals, organized by division and section, with a proposed date for each item to be submitted. This shall coordinate with the construction schedule.
 - a. As the project progresses, update the Submittal Log with the date submittal was sent, days since submittal was sent, status of submittal, date submittal was received in return, and any date associated with resubmittals.
 - b. Update the Submittal Log with each submission and response.
 - c. Issue copy of the updated Submittal Log electronically with each Application for Payment or upon request by the User Agency.
 - d. The provision of the required mock-ups shall be integrated with the submittal schedule for a timely execution.
- B. Preparation and transmission of submittals:
 - a. Identify all variations from the Contract Documents and any Product or system limitations which may be detrimental to a successful performance of the completed Work.
 - b. Allow space on the submittals for the Contractor's, Design Agent's, and Consultant's electronic review stamps.
 - c. Transmit each submittal with a dated Design Agent-accepted transmittal form.
 - d. Sequentially number the transmittal form. Mark revised submittals with an original number and a sequential alphabetic suffix.

- e. Number the submittals as follows:
 - . 000000-001-001: Six-digit MasterFormat, with consecutive 3-digit placeholders. The first is sequential by the submittal in that section. The second is the version number, with the first submittal being 001 (not 000). Incorrectly numbered submittals will be returned for correction without review.
 - f. Identify the Project, Contractor, subcontractor and supplier; the pertinent drawing and detail number, and the specification Section number, appropriate to the submittal.
 - g. Apply a Contractor's electronic stamp certifying that the review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of the information is in accordance with the requirements of the Work and the Contract Documents.
 - h. Transmit printed copies and electronic PDF copy of each submittal to the Design Agent for review and comment as outlined in Section.
- C. Submittal Review & Resubmission
- a. For each submittal, allow fifteen (15) calendar days for review.
 - b. When revised for resubmission, identify the changes made since the previous submission.
 - c. Distribute copies of the reviewed submittals as appropriate. Reproduce as necessary to inform subcontractors without internet download capabilities. Instruct the parties to promptly report any inability to comply with the Contract requirements.
 - d. Produce additional copies as required for the Record Document purposes as described in Section 01 78 00.

1.3 SITE SUPERINTENDENT

- A. Immediately after the issuance of the Purchase Order, Contractor shall submit the name, email, cell phone, resume of the proposed site superintendent for review and approval by the Design Agent and User Agency.
- B. The site superintendent shall be familiar with the drawings and specifications.
- C. No substitution or replacement of the site superintendent shall be made without notifying the Design Agent and User Agency.

1.4 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial progress schedule in duplicate within ten (10) days of issuance of Purchase Order for Design Agent and User Agency. Upon receipt of reviewed comments, Contractor to submit detailed schedules within five (5) days.
- B. Distribute copies of the reviewed schedules to the Project site file, subcontractors, suppliers, and other concerned parties. Instruct the recipients to promptly report, in writing, the problems anticipated by the projections indicated in the schedules
- C. Submit updated schedules with each Application for Payment, identifying changes since previous version as follows:
 - a. Indicate the progress of each activity to the date of submittal, and the projected completion date of each activity.
 - b. Identify the activities modified since the previous submittal, major changes in the scope, and other identifiable changes.
 - c. Provide a narrative report to define the problem areas, the anticipated delays, and impact on the Schedule. Report the corrective action taken, or proposed, and its effect including the effect of changes on the schedules of separate contractors.

- D. Submit a computer-generated horizontal bar chart with separate line for each major portion of the Work or operation, identifying the first work day of each week.
- E. Show a complete sequence of construction by activity, identifying the Work of separate stages and other logically grouped activities. Indicate the early and late start, the early and late finish, float dates, and duration. Critical path items shall be clearly identified.
- F. Indicate an estimated percentage of completion for each item of the Work at each submission.
- G. Provide a separate schedule of submittal dates for shop drawings, product data, and samples, including User Agency-furnished Products and Products identified under Allowances, if any, and the dates reviewed submittals will be required from the Design Agent. Indicate the decision dates for selection of the finishes.
- H. Indicate the delivery dates for User Agency furnished Products, and for Products identified under Allowances.

1.5 SUBCONTRACTOR LIST

- A. Provide subcontractor list per General Conditions §5.2.1. For each subcontractor, provide contact name, phone number, trade and email. Indicate the SOV line item(s) for which the subcontractor will be providing and if labor will be provided.

1.6 PROPOSED PRODUCTS LIST

- A. Within ten (10) days of issuance of Purchase Order, submit a list of major products proposed for use, with the name of the manufacturer, the trade name, and the model number of each product.
- B. For the products specified only by reference standards, give the manufacturer, trade name, model or catalog designation, and reference standards.
- C. With each product listed, indicate the submittal requirements specified to be adhered to, and an indication of relevant "long-lead-time" information, when appropriate.

1.7 PRODUCT DATA

- A. Product Data: Submit to the Design Agent for review for the limited purpose of checking for conformance with the information given and the design concept expressed in the Contract Documents. Provide copies and distribute in accordance with the SUBMITTAL PROCEDURES article and for the record documents purposes described in Section 01 78 00.
- B. Submit one (1) printed copy and one (1) electronic PDF copy for review. The Design Agent will retain the reviewed printed copy for record and return the reviewed electronic PDF copy to the Contractor for distribution.
- C. Mark each copy to identify the applicable products, models, options, and other data. Supplement the manufacturers' standard data to provide the information specific to this Project.
- D. Indicate the product utility and electrical characteristics, the utility connection requirements, and the location of utility outlets for service for functional equipment and appliances.
- E. After a review distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 01 78 00.

1.8 SHOP DRAWINGS

- A. Shop Drawings: Submit to the Design Agent for review for the limited purpose of checking for conformance with the information given and the design concept expressed in the Contract Documents. Produce copies and distribute in accordance with the SUBMITTAL PROCEDURES article and for the record documents purposes described in Section 01 78 00.

- B. Submit two (2) printed copies and one (1) electronic PDF copy for review. The Design Agent and /or Consultants will retain the reviewed printed copies for record and return the reviewed electronic PDF copy to the Contractor for distribution.
- C. Indicate the special utility and electrical characteristics, the utility connection requirements, and the location of utility outlets for service for functional equipment and appliances.
- D. Where indicated in the individual section provide engineered shop drawings along with calculations stamped by a licensee professional registered in Rhode Island.

1.9 SAMPLES

- A. Samples: Submit to the Design Agent for review for the limited purpose of checking for conformance with the information given and the design concept expressed in the Contract Documents. Produce duplicates and distribute in accordance with the SUBMITTAL PROCEDURES article and for the record documents purposes described in Section 01 78 00.
- B. Samples for Selection as Specified in Product Sections:
 - a. Submit to the Design Agent for aesthetic, color, or finish selection.
 - b. Submit samples of the finishes in the colors selected for the Design Agent's records.
 - c. After review, produce duplicates and distribute in accordance with the SUBMITTAL PROCEDURES article and for the record documents purposes described in Section 01 78 00.
- C. Submit samples to illustrate the functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate the sample submittals for interfacing Work.
- D. Include identification on each sample, with the full Project information.
- E. Submit at least the number of samples specified in the individual specification Sections; the Design Agent will retain two samples.
- F. Reviewed samples, which may be used in the Work, are indicated in the individual specification Sections.
- G. Samples will not be used for testing purposes unless they are specifically stated to be in the specification Section.

1.10 TEST REPORTS

- A. Submit (1) printed and (1) electronic PDF lab reports in accordance with Section 01 40 00.
- B. Submit test reports for information for the limited purpose of assessing conformance with the information given and the design concept expressed in the Contract Documents.

1.11 DESIGN DATA

- A. Submit (1) printed and (1) electronic PDF data for the Design Agent's knowledge as contract administrator for the User Agency.
- B. Submit information for the limited purpose of assessing conformance with the information given and the design concept expressed in the Contract Documents.

1.12 CERTIFICATES

- A. When specified in the individual specification Sections, submit (1) printed and (1) electronic PDF certification by the manufacturer, installation/application subcontractor, or the Contractor to the Design Agent in the quantities specified for the Product Data.
- B. Indicate that the material or product conforms to or exceeds the specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

- C. Certificates may be recent or previous test results on the material or product, but must be acceptable to the Design Agent and its Consultants.

1.13 MANUFACTURER'S INSTRUCTIONS

- A. When specified in the individual specification Sections, submit (1) printed and (1) electronic PDF copy of instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to the Design Agent for delivery to the User Agency in the quantities specified for Product Data.
- B. Indicate the special procedures, and the perimeter conditions requiring special attention, and the special environmental criteria required for application or installation.

1.14 MANUFACTURER'S FIELD REPORTS

- A. Submit (1) printed and (1) electronic PDF of reports for the Design Agent's benefit as contract administrator for the User Agency.
- B. Submit the report within 30 days of observation to the Design Agent for the limited purpose of assessing conformance with the information given and the design concept expressed in the Contract Documents.

1.15 ERECTION DRAWINGS

- A. When specified in the individual Specification sections, the trade contractors shall submit (1) printed and (1) electronic PDF copy of erection drawings for review prior to proceeding with fabrication and/or construction.
- B. Erection drawings shall be prepared in accordance with the latest edition of the respective trades' codes of standard practice.
- C. All erection drawings shall be fully developed by the trade contractors or by agents of the contractors. CAD files, photocopies, or other reproductions of the contract drawings in whole or in part shall not be used by the trade contractors or their agents for the preparation and development of erections drawings without the expressed written consent of the Design Agent.

1.16 SUBMITTAL LIST

- A. As specified in the individual specifications.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 01 – FORM: REQUEST FOR SUBMITTAL REVIEW – COVER

REQUEST FOR SUBMITTAL REVIEW COVER

Contractor’s Contact Information:	Project Number (Contractor/Architect):	Contractor Package Number (if applicable):

Date of Submittal:	Submittal Number		
	Specification Section (6 digit) i.e. 00 00 00	Sequential # (3 digit)	Version # (3 digit – start w/ 001)

Submittal Name:	Submittal Type: (Product Data, Shop Drawing, Test Report, Sample, Mock-up, other):
Specification Requirement (Cite Part 1):	
The contractor requests review comments are provided by the following date:	
Deviation Requests included herein:	Yes: _____ No: _____
Options requiring selection by Architect are clearly identified.	Yes: _____ N.A.: _____

Contractor Review Certification:

<p>The attached submittal is the contractor’s work plan for this portion of the specified Work. This submittal was either prepared by the contractor directly, or under their direct supervision by their employee or subcontractor. Specified execution or schedule requirements have been coordinated with the project schedule.</p> <p>The accompanying signature signifies that the contractor’s review is complete and is approved by them. Deviation requests for A/E approval (if any) are made and explained on a separate page. Any options requiring Architect/Engineer selection are clearly identified.</p>	Print name of Contractor’s reviewer:
	Signature of Contractor’s reviewer:
	Date of Contractor’s approval:

END OF SECTION 01 33 01

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SECTION 01 33 02 – FORM: REQUEST FOR SUBMITTAL REVIEW – PDCS

REQUEST FOR SUBMITTAL REVIEW - PRODUCT DATA CONTINUATION SHEET (PDCS)

For product submittals, list each product individually. Use additional pages as needed.

SUBMITTAL NAME

SUBMITTAL NUMBER
_____ - _____ - _____

	LIST PRODUCTS IN THIS SUBMITTAL	INDICATE PART 2 SPECIFICATION PARAGRAPH (I.E. 2.2) WHERE PRODUCT IS SPECIFIED.	PRODUCT MANUFACTURER	PRODUCT NAME OF LINE OR MODEL #	PRODUCT COLOR/ FINISH	G.C. INDICATE THE PAGE NUMBERS IN THIS SUBMITTAL
1.						1 -
2.						
3.						
4.						
5.						
6.						
7.						

8.						
9.						
10 .						
11 .						
12 .						
13 .						
14 .						
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16 .						
17 .						
18 .						

SECTION 01 35 16 - ALTERATION PROJECT PROCEDURES

1 PART 1 - GENERAL

1.1 SUMMARY

- A. Special requirements and considerations for renovation and alternation work including, but not limited to, the following:
 - 1. Special requirements for temporary protection of existing finishes and building components.
 - 2. Transitions and adjustments.
 - 3. Procedural requirements for Alterations.
 - 4. Repair of damaged surfaces, finishes, and cleaning.
 - 5. Repair of concrete slab and roofing system.
 - 6. General requirements for rehabilitation and renovations of existing spaces and materials.

1.2 RELATED REQUIREMENTS

- A. Section 01 73 29 - CUTTING AND PATCHING:
 - 1. Procedural and administrative requirements for cutting and patching.
- B. Section 02 41 00 - DEMOLITION: Demolition of selected portions of the building for new construction.

1.3 GENERAL RENOVATION REQUIREMENTS

- A. General: The work required by the Contract Documents includes alterations and renovation of existing construction.
- B. Rework, rebuild, and repair existing construction and surfaces to eliminate damaged and deteriorated materials and construction, and to create continuous "like new appearance and conditions":
 - 1. At each interface between new and existing work. Where damage or holes are caused by installation of new work.
 - 2. At each location of demolition and removal of existing work.
 - 3. Wherever the Contract Documents indicate work on existing surfaces.
 - 4. At all existing construction and surfaces to remain except those specifically noted as "No Work Required".
- C. All items required to be moved to facilitate work shall be carefully carried or conveyed.
- D. Use qualified personnel for alteration and restoration work.
- E. Protect and maintain existing finishes, surfaces, and substrates indicated to remain, indicated to remain "with specific cleaning", or indicated to remain "with new finishes".
- F. Protect existing surfaces from damage, vandalism, graffiti, impressions, marks, and defects.

- G. Locate protection where it will serve the project adequately and result in minimum interference with performance of the work.
- H. Protection may be required to remain in place for the duration of the project. As such, materials should be installed to provide adequate protection throughout the full extent of construction activities. Repair or reinstall protection throughout the duration of construction as required.
- I. Renovation Work Patching: Comply with requirements indicated throughout the Contract Documents for each type of patching, repair, and finish work.

1.4 SUBMITTALS

- A. Submit the following under provisions of Section 01 33 00 -SUBMITTAL PROCEDURES:
 - 1. Shop drawings: Show extent and location of temporary protection of existing building elements and finishes. Existing construction drawings may be used as base sheets for shop drawings.
 - 2. Proposed methods of protection for review and approval prior to the commencement of work.

1.5 REFERENCES

- A. Referenced Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Section 01 42 00 - REFERENCES. The standards referenced herein are included to establish recognized minimum quality only. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.
- B. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Section 01 42 00 -REFERENCES.
 - 1. ANSI A 10 - Safety Requirements for Construction and Demolition.
 - 2. NFPA 241 - Building Construction and Demolition Operations.
 - 3. ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition".

1.6 REGULATORY REQUIREMENTS

- A. Conform to specified procedures applicable when discovering hazardous materials or contaminated substances.
 - 1. Immediately notify both the Owner and the Architect upon discovery of hazardous materials or contaminated substances.
 - 2. Removal or containment of the hazardous materials or contaminated substances shall be performed by the hazardous materials specialist subcontractor specifically licensed to perform such work.
- B. Obtain and pay for required permits and licenses required from authorities prior to commencing demolition work. Arrange and pay for legal disposal of removed materials and equipment, obtain proper disposal receipts for verification.

- C. Do not close or obstruct egress width to exits. Do not disable or disrupt building fire or life safety systems without 3 days prior written notification to the Owner.

1.7 QUALITY ASSURANCE

- A. The General Contractor is responsible for protection of all existing materials and components to remain or to be salvaged. In the event of damage, such items shall be immediately repaired or replaced by the Contractor, at his expense, to the satisfaction of the Architect.
- B. The Contractor is hereby directed to recognize the value and significance of the building, and exercise special care during all phases of the work to ensure that the existing building, its details, materials and finishes which are to remain or to be salvaged are not damaged by the work being performed.
- C. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with specified requirements and methods needed for proper performance of the work of this Section.

1.8 PROJECT CONDITIONS

- A. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- B. Protections shall remain in place for the duration of the project unless determined otherwise by the Architect.
- C. Coordinate the performance of work of this section with related or adjacent work. Protection of items should be complete prior to commencement of demolition and construction.

1.9 SEQUENCING AND SCHEDULING

- A. Conduct alteration and restoration work in a manner giving prime consideration to protection of the public; protection from the weather, control of noise, shocks and vibration; control of dirt and dust; orderly access for and storage of materials; protection of existing buildings; protection of adjacent surfaces and property; coordination and cooperation with the Owner at all times.
- B. Coordinate and arrange with mechanical and electrical trades for their disconnecting, rerouting and maintenance of existing services in the buildings as required, as part of the work of this Contract.
- C. Adhere to approved locations for trash chutes, and areas for storage of materials.
- D. Provide necessary protection to completely cover all remaining adjacent surfaces, existing equipment, furniture and furnishing during demolition and construction operations.
- E. Equipment Access: Provide access for all large scale equipment furnished and installed under this contract. Should existing openings require enlargement, enlarge same and replace to former condition.

3 PART 2 – PRODUCTS

2.1 PRODUCTS FOR PROTECTION

- A. General: Materials used for protection of existing finishes and surfaces: sound materials and of adequate dimension for the intended use. Temporary protection materials shall be properly supported, braced, tied, and arranged to ensure absolute safety for those using the equipment and sufficient to safely withstand all loading and stress.
 - 1. Temporary protection shall not puncture, scar, or damage walls or other finish construction.
- B. Lumber and Plywood:
 - 1. Lumber: Hem-Fir, Douglas Fir, Eastern Spruce, Eastern Hemlock, or Southern Pine, surfaced dried stud or utility grade.
 - 2. APA graded C-D-X EXT, Group 2 species, thickness as required.
- C. Wood fiber board, equal to Homasote Company, Trenton NJ., product "HCFR Homasote", 4 by 8 foot panel, 1/2 inch thick.
- D. Clear polyethylene film, 0.006 inches (6 mil) thick provided in full-wall length and width pieces, without joints, wherever possible.
- E. Neoprene: 1/4-inch or 1/2-inch stock sizes.
- F. Protection paper: Canadian red-rosen paper or kraft paper.
- G. Accessories: Provide necessary and related parts, devices and anchors required for complete installation.

2.2 PRODUCTS FOR PATCHING AND EXTENDING WORK

- A. General: Provide new materials. If acceptable to the Architect, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.
- B. New Materials: As specified in individual Sections, match existing products and work for patching and extending work. Determine type and quality of existing products by inspection and any necessary testing, and workmanship by use of existing as a standard. Presence of a product, finish, or type of work, requires that patching, extending, or matching shall be performed as necessary to make Work complete and consistent with existing quality.

2.3 CONCRETE SLAB PATCHING

- A. Cementitious Materials: Use the following cementitious materials, of the same type, brand and source, throughout Project:
 - 1. Portland Cement: ASTM C150, Type I/II, gray.
- B. Normal-Weight Aggregates: ASTM C33, Class 3S coarse graded or better, graded.
 - 1. Maximum Coarse-Aggregate Size: 3/4" inch nominal in steel-reinforced slabs.
- C. Water: ASTM C94/C 94M and potable

2.4 ROOF REPAIRS

- A. Match existing roof assembly in kind and dimensions.
- B. Provide flashing, sealants, and roofing materials to provide weathertight transitions to the new the new equipment and roof penetrations.

2.5 EQUIPMENT

- A. Existing Equipment Designated To Be Relocated: Relocate existing fixed equipment designated to be relocated.
 - 1. Disconnect and reconnect existing relocated equipment to building services.
 - 2. Make all terminal connections to the mechanical and electrical services.
 - 3. Receive, check and place equipment in designated position.
 - 4. A schedule of room locations of the items of existing equipment will be furnished by the Architect.

4 PART 3 – EXECUTION

3.1 PROTECTION OF EXISTING BUILDING FINISHES AND COMPONENTS

- A. General: Provide temporary enclosure for protection of construction in progress and completed, from exposure, foul weather, other construction operations and similar activities.
 - 1. Provide all temporary protection, including planking, barricades, signs, necessary to protect personnel and the public from equipment and construction operations. Take all required measures to protect the existing building (contents, surfaces, or materials) and site from damage of any kind when performing the Work.
- B. Existing Building Elements to Remain:
 - 1. Interior finishes must be physically isolated from construction operations by means of protective barriers and coverings.
 - 2. Protect all existing building elements to remain in place which may be damaged by construction activities. In the event of new damage, inform the Architect immediately as to the nature and extent of damage and the proposed method of repair.
 - 3. Do not attach protection materials directly to existing finished surfaces which might be damaged by such attachment. Do not use duct tape or mechanical fasteners on existing finished materials unless so directed by Architect.
 - 4. Protection to be secured adequately so as to maintain a safe environment for workers and other individuals using the building throughout the duration of the project.
 - 5. Provide all temporary protections as may be required to ensure that all components of existing building indicated to remain are not damaged during the execution of the Work.
 - 6. Closed Areas: Closed areas shall be those rooms where access is not required for construction activities. These rooms shall be locked at the outset of construction for protection from construction activities, and shall be maintained locked during the entire course of construction. No construction activities shall be permitted in these areas, including storage of construction materials. Primary Path of Travel: Those areas which will experience a high degree of traffic, primarily at the lobbies and main corridors.

7. Secondary Path of Travel: All other areas outside the required path for heavy construction, where access is required to perform secondary construction procedures. The Secondary Path of Travel shall be locked, and access shall be controlled and limited by the Contractor.
- C. Dust Protection where demolition work is required.
1. General: Comply with requirements of Section 01 56 16 - TEMPORARY DUST BARRIERS.
 2. Seal all floor, wall and ceiling openings to prevent the intrusion of dust into these spaces. Provide dust curtains at doors.
 3. Construct temporary partitions surrounding the area of construction in these areas.
 4. Dust-Proof Wrap: Cover surfaces with polyethylene plastic. Seal seams completely with duct tape. Anchor to protection wherever possible. Attach to historic materials with preservation tape. Do not use duct tape or mechanical fasteners on historic materials.
 5. Dust-Proof Temporary Partitions: Construct floor to ceiling wood frame with 2 x 4-inch, or 2 x 6-inch lumber at 16-inches on center. Staple double layers of polyethylene plastic to either side, seal seams with duct tape. Seal interface with unprotected materials with preservation tape.
- D. Ceilings: Provide dust-proof wrap on all acoustical tile ceilings and other acoustic and fabric ceiling surfaces.
- E. Miscellaneous moldings, trim and surrounds, including, but not limited to: Stone column covers, wood picture moldings, chair rails, bases, window and door surrounds, and other miscellaneous stone finishes and millwork:
1. Primary Path of Travel: Extend wall protection over these elements.
 2. Secondary Path of Travel: Verify extent of potential impact to these elements with Architect. If protection is required, carefully protect in place as specified for floors.
- F. Wood Doors and Frames:
1. Primary Path of Travel: Protection will consist of 1/2-inch soft fiberboard and plywood screwed to 2 by 4 inch shoring braces set at 16-inches to four feet apart. Existing door to be removed and stored during construction. Provide a temporary door and complete enclosure of existing door surrounds.
 2. Secondary Path of Travel: Verify extent of potential impact to these elements with Construction Manager. If protection is required carefully remove these elements for reinstallation and protect frame as specified.
- G. Miscellaneous Hardware: Verify extent of potential impact to these elements with Architect. Where protection is required, carefully remove and catalog these elements for reinstallation.
- H. Light Fixtures: Verify extent of potential impact to these elements with Architect. Remove, catalog and store impacted fixtures.
- I. Weather Protection: Protect existing building interior and all materials and equipment from weather at all times. Temporary coverings shall be attended as necessary to insure effectiveness and to prevent displacement.
- J. Contractor shall repair or replace all elements of the building damaged by failure to properly protect them from the weather to the satisfaction of the Architect at no additional cost to the Owner.

3.2 PREPARATION

- A. Cut, move or remove items as necessary for access to alterations and renovations work; replace and restore at completion.
- B. Remove unsuitable material not marked for salvage, such as rotted wood, rusted metals, and deteriorated masonry and concrete; replace materials as specified for finished work.
- C. Remove debris and abandoned items from area and from concealed spaces.
- D. Prepare surfaces and remove surface finishes to provide for proper installation of new work and new finishes.
- E. In areas where new base is scheduled to be installed on existing surfaces, the existing base shall be removed and the surface patched in preparation for the installation of new material.
- F. Coordinate with trades involved for the installation of new materials in establishing exact locations of materials to be removed.
- G. Clean, prepare and level all existing floors. All floor surfaces shall be left smooth, free from abrupt ridges, pits, cracks, depressions, dust, oil or other materials which will have adverse effect on, or will cause discoloration or damage to finished floor materials.
- H. Where alterations occur or new and old work join, the immediate, adjacent surfaces shall be cut, removed, patched, repaired or refinished and left in as good a condition as existing prior to the start of the work. The materials and workmanship employed in the alterations involved by the new construction, unless otherwise indicated or specified shall conform to that of the original work.

3.3 PREPARATION – SUBFLOORS AND FINISH FLOORING SUBSTRATE

- A. General: Substrates: These requirements apply to existing subfloors and are in addition to preparation required for new subfloors and substrates.
- B. Removal of existing flooring, as specified under Section 02 41 00 - DEMOLITION with additional requirements specified herein.
 - 1. Completely remove existing flooring located in areas scheduled to receive new flooring surfaces and elsewhere as noted. Remove all layers of flooring down to the existing substrate. Where existing flooring is installed in a setting bed, the existing setting bed shall be completely removed and floor leveled with concrete.
- C. Remove resilient flooring and adhesive in strict accordance with the technical bulletin entitled "Recommended Work Practices for the Removal of Resilient Floor Covering", as issued by Resilient Floor Covering Institute, Rockville, MD. Preparation of existing floors:
 - 1. Remove all foreign materials from existing floor surfaces by use of mechanical abraders, grinders or other methods required to clean the existing surfaces to a smooth clean finish acceptable for the application of new flooring surfaces or cementitious underlayment.
 - 2. Chemicals required for cleaning of floors shall be free of fumes and odors which will affect building occupants. Obtain Owner's approval for use of all such chemicals prior to start of work.

3.4 INSTALLATION

- A. Coordinate work of alterations and renovations to expedite completion of Work.
- B. Remove, cut, and patch work in a manner to minimize damage and to provide means of restoring products and finishes to original or specified condition.
- C. Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat transition to adjacent new finishes.
- D. Install products as specified in individual Sections.

3.5 ENCLOSURE OF EXPOSED PIPES AND CONDUIT

- A. Exposed piping and conduit in existing spaces: Not all chases and enclosures required in renovated areas are shown on drawings.
 - 1. Provide chases with finishes matching surrounding materials to enclose and completely conceal all new piping, ducts, and conduits located in renovated finished spaces.
 - 2. Build chases out of new materials specified under individual product specification sections, matching surrounding abutting m
 - 3. Construct chases and enclosures as small as possible, unless otherwise approved by Architect.
 - 4. Align new chases and enclosures with existing major architectural lines and planes.

3.6 TRANSITIONS

- A. Where new work abuts or aligns with existing, make a smooth and even transition. Patched work shall match existing adjacent work in texture and appearance.
- B. When surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and notify Architect.

3.7 ADJUSTMENTS

- A. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps or bulkheads. Trim existing doors as necessary to clear new floor finishes; refinish trimmed areas.
- B. In any existing area in which a wall is furred, floor raised or ceiling dropped, all mechanical and electrical devices at that area shall be moved, relocated or rerouted in such manner that all work within that area shall conform to the new lines of work established by such indicated furring of walls, raising of floors or dropping of ceilings. The attention of all trades is directed to existing conditions and the various drawings for locations of work.

3.8 REMOVAL OF TEMPORARY PROTECTION

- A. Remove temporary materials and construction at Substantial Completion. Comply with requirements of Section 01 50 00 -TEMPORARY FACILITIES AND CONTROLS.

3.9 FINISHES

- A. Finish surfaces as specified in individual product specification sections.
- B. Finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.
- C. Provide complete restoration of areas damaged due to work under the contract, to a condition equal to or similar to that existing before damage or injury. Restoration shall include repairing, rebuilding, or replacing damaged items at contractor's expense.

3.10 REPAIR OF EXISTING SURFACES

- A. Restore existing facilities used during construction to original conditions. Restore permanent facilities used during construction to specified condition.
- B. Repair substrates prior to patching finish.
- C. Repair and clean existing finishes and materials damaged in the performance of the Work of this Contract.
- D. Repair existing finishes and materials damaged by installation or use of temporary work.
- E. General: Comply with cleaning requirements specified in Section 01 73 00 - EXECUTION.

3.11 CLEANING OF EXISTING SURFACES

- A. General Cleaning: Immediately before Owner occupancy, thoroughly and completely scrub and clean all existing interior finishes, and surfaces indicated to remain in the finished work. Leave floors, walls, windows, ceilings and all other surfaces clean and undamaged
 - 1. Remove all dirt, soil, stains, graffiti, and marks.
 - 2. Remove paint and smears.
 - 3. Clean all glass surfaces (inside and outside).
 - 4. Replace scratched glass.

END OF SECTION

01 35 24 – MANAGING FIRE PROTECTION SYSTEM IMPAIRMENT

PART 1 - GENERAL

1.1 IMPLEMENTATION

- A. The following management procedure applies to the Contract for Construction and is a part of the Contract Documents.

1.2 MANAGING FIRE PROTECTION SYSTEM IMPAIRMENT

- A. Impairment to fire protection equipment is a situation in which the system is shut off, either in whole or in part. The impairment may be necessary to conduct scheduled maintenance of equipment or to make emergency repairs. Impairment may also be due to new construction. Normal system tests and inspections are not considered impairment.
- B. Regardless of the reason, impairment results in the sprinkler system and/or fire alarm system being temporarily out of service, such a condition may result in severe property loss in the event of a fire. Locations protected by automatic sprinkler systems must have an impairment handling program to control situations when sprinkler systems must be shut down.
- C. Whenever a sprinkler system has been impaired all hot work in the area of the impaired system should be prohibited.
- D. A periodic fire watch should be established when either the sprinkler system or the fire alarm system is out of service.
- E. The State's property insurance carrier recommends an impairment handling kit. The Red Tag Permit System consists of four key elements:
- a. A Red Tag Permit
 - b. Fire Protection Equipment Decals: are to be affixed to fire protection equipment as a reminder that authorization is needed before any shut down can occur.
 - c. Reusable Impairment Tag for Fire Service Connections: There is space on the notification tag for the phone numbers of the Fire department, Alarm Company, and the local Water Department as well.
 - d. Red Tag Permit System Wall Hanger: contains pockets to keep other elements of the system organized and within reach; also the Hanger lists steps to be taken before, during and after impairment. The Wall Hanger also lists the contact to be notified of the impairment.
- F. An engineer and/or client service representative can advise you on how to proceed and follow up until protection has been restored. In addition this representative may be able to help minimize downtime, if possible, reduce fire exposure to the area, arrange for temporary protection and determine how to restore protection as quickly as possible.
- G. For scheduled maintenance of fire alarm systems, vendors must, as prescribed in Rhode Island Fire Codes, notify the User Agency 48 hours in advance of pending maintenance.
- H. As part of base contract, the Contractor is required to provide a licensed electrician to oversee and perform the required temporary modifications to the fire alarm system during the impairment, including bypass control during fire sprinkler work. The College will not provide personnel for this purpose.

END OF SECTION



OFFICE OF CAPITAL PROJECTS | 600 MOUNT PLEASANT AVE, PHYSICAL PLANT, PROVIDENCE, RI 02908

FIRE SPRINKLER AND ALARM SYSTEM IMPAIRMENT NOTIFICATION FORM

To: RIC Office of Capital Projects

Date: _____

Start of Planned Impairment: _____

End of Planned Impairment: _____

Building occupied during impairment: Yes:____ No:____

Any hot work to be performed: Yes:____ No:____

Description of Work to be performed:

RIC Trade & Fire Alarm Safety Manager, David Benevides, can also be directly contacted at 401-456-4747.


Contractor supervisory personnel shall remain in the building for the entire duration of the impairment.

Name: _____

Company: _____

Phone: _____

RED TAG PERMIT

CONTROL NUMBER 2151373	INDEX NUMBER
PRECAUTIONS TAKEN (CHECK AS APPROPRIATE)	
<input type="checkbox"/> Emergency Organization Notified	<input type="checkbox"/> Continuous Work Authorized
<input type="checkbox"/> Public Fire Department Notified	<input type="checkbox"/> Ongoing Patrol of Area
<input type="checkbox"/> Hazardous Operations Stopped	<input type="checkbox"/> Hydrant Connected to Sprinkler Riser
<input type="checkbox"/> Hot Work Prohibited	<input type="checkbox"/> Pipe Plugs on Hand
<input type="checkbox"/> Smoking Restricted	<input type="checkbox"/> Fire Hose Laid Out
<input type="checkbox"/> Other _____	
CONTACT NAME	
LOCATION (City, State/Province)	
CONTACT PHONE NO.	CONTACT FAX NO.
CHECK IF	SPRINKLER VALVE LOCATION/NUMBER
<input type="checkbox"/> SPRINKLER	
<input type="checkbox"/> FIRE PUMP	
<input type="checkbox"/> CO ₂	AREA PROTECTED
<input type="checkbox"/> HALON	
<input type="checkbox"/> OTHER	
REASON FOR IMPAIRMENT	
PLANNED DATE/TIME TO BE CLOSED	
PLANNED DATE/TIME TO BE OPEN	
NAME/TITLE OF RESPONSIBLE PERSON	
AUTHORIZED BY (NAME)	FIRE PROTECTION EQUIPMENT OPERATOR (NAME)
PART 1 INSTRUCTIONS	
Permit Authorizer: Fill out using ballpoint pen, sign and issue permit as follows:	
Phone Part 1 information, or fax this part, to the FM Global number listed on the Red Tag Permit Wall Kit.	
Place Part 2 in center pocket of Wall Kit as visual reminder of impairment.	
Issue Part 3 (Red Tag) to Fire Protection Equipment Operator to attach to impaired equipment.	
	
RED TAG PERMIT	
Part 1 of 3	
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END OF ATTACHMENT

01 40 00 – QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Quality control and control of installation.
- B. Contractor Qualifications
- C. Verification of Credentials and Licenses.
- D. Tolerances
- E. References.
- F. Testing and inspection services.
- G. Manufacturers' field services.
- H. Mock-up Requirements.
- I. Testing and Balancing.
- J. Repair of Defective Construction
- K. Coordination Drawings

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor a quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of the specified quality.
- B. Comply with all manufacturers' instructions and recommendations, including each step in sequence.
- C. When the manufacturers' instructions conflict with the Contract Documents, request a clarification from the Design Agent before proceeding.
- D. Comply with the specified standards as a minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform the Work by persons qualified to produce the required and specified quality.
- F. Verify that field measurements are as indicated on the 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, or disfigurement.

1.3 VERIFICATION OF CREDENTIALS AND LICENSES

- A. The User Agency has implemented a project management oversight process and is applying it to current construction projects at RIC.
- B. An element of this oversight process is the verification that persons employed on the project site have appropriate and current credentials and licenses in their possession, at the project site, for the work they are performing.
- C. Be forewarned that state resident inspectors will be checking for verification of credentials and licenses of both union and non-union persons, in their onsite inspections.

- D. State resident inspectors will also be reviewing Contractor's Certified Monthly Payroll Records for conformance with RI State Prevailing Wage Rate requirements.
- E. Those persons without the appropriate credentials and licenses will be subject to dismissal from the project site.

1.4 TOLERANCES

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

1.5 REFERENCES

- A. For products or workmanship specified by association, trade, or other consensus standard, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by the date of issue current on the date of the Contract Documents, except where a specific date is established by code.
- C. Obtain copies of the standards where required by the product specification Sections.
- D. When the specified reference standards conflict with the Contract Documents, request a clarification from the Design Agent before proceeding.
- E. Neither the contractual relationships, duties, nor responsibilities of the parties in the Contract, nor those of the Design Agent, shall be altered from the Contract Documents by mention or inference otherwise in reference documents.

1.6 TESTING AND INSPECTION SERVICES

- A. The Contractor will submit the name of an independent firm to the Design Agent for approval by the User Agency, to perform the testing and inspection services.
 - a. Base Bid Testing Requirements List. The Contractor shall pay for all the services required in the Base Bid as described:
 - a. No testing services are required.
 - b. Additional User Agency-Authorized Testing Requirements List Contractor shall coordinate any User Agency-authorized additional testing also described to be paid for from Testing Allowance:
 - a. Not Applicable
- B. The independent firm will perform the tests, inspections and other services specified in the individual specification Sections and as required by the Design Agent or its Consultants.
 - a. Laboratory: Authorized to operate in the location in which the Project is located.
 - b. Laboratory Staff: Maintain a full time registered Engineer on staff to review the services.
 - c. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to either the National Bureau of Standards or to the accepted values of natural physical constants.

- C. Testing, inspections and source quality control may occur on or off the project site. Perform off-site testing as required by the Design Agent or the User Agency.
- D. Reports will be submitted by the independent firm to the Design Agent, the Consultant for that trade, and the Contractor, in duplicate, indicating the observations and results of tests and indicating the compliance or non-compliance with Contract Documents.
- E. Cooperate with the independent firm; furnish samples of the materials, design mix, equipment, tools, storage, safe access, and the assistance by incidental labor as requested.
 - a. Notify the Design Agent and Engineer and the independent firm 24 hours prior to the expected time for operations requiring services.
 - b. Make arrangements with the independent firm and pay for additional samples and tests required for the Contractor's use.
- F. Testing and employment of the testing agency or laboratory shall not relieve the Contractor of an obligation to perform the Work in accordance with the requirements of the Contract Documents.
- G. Re-testing or re-inspection required because of a non-conformance to the specified requirements shall be performed by the same independent firm on instructions by the Design Agent or its Consultant. Payment for the re-testing or re-inspection will be charged to the Contractor by deducting the testing charges from the Contract Sum.
- H. Agency Responsibilities:
 - a. Test samples of mixes submitted by the Contractor.
 - b. Provide qualified personnel at the site. Cooperate with the Design Agent or its Consultant and the Contractor in performance of services.
 - c. Perform specified sampling and testing of the products in accordance with the specified standards.
 - d. Ascertain compliance of the materials and mixes with the requirements of the Contract Documents.
 - e. Promptly notify the Design Agent, Consultant and the Contractor of observed irregularities or non-conformance of the Work or products.
 - f. Perform additional tests required by the Design Agent or its Consultants.
 - g. Attend the preconstruction meetings and the progress meetings.
- I. Agency Reports: After each test, promptly submit two copies of the report to the Design Agent, appropriate Consultant, and to the Contractor. When requested by the Design Agent, provide an interpretation of the test results. Include the following:
 - 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 inspection or test.
 - h. Date of test.
 - i. Results of tests.
 - j. Conformance with Contract Documents.
- J. Limits On Testing Authority:

- a. Agency or laboratory may not release, revoke, alter, or enlarge on the requirements of the Contract Documents.
- b. Agency or laboratory may not approve or accept any portion of the Work.
- K. Agency or laboratory may not assume any duties of the Contractor.
- L. Agency or laboratory has no authority to stop the Work.

1.7 MANUFACTURERS' FIELD SERVICES

- A. When specified in the individual specification Sections, require the material or Product suppliers, or manufacturers, to provide qualified staff personnel to observe the site conditions, the conditions of the surfaces and installation, the quality of workmanship, the start-up of equipment, or test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.
- B. Submit the qualifications of the observer to the Design Agent 30 days in advance of the required observations. Observer is subject to approval of the Design Agent.
- C. Report the observations and the site decisions or instructions given to the applicators or installers that are supplemental or contrary to the manufacturers' written instructions.
- D. Refer to Section 01 33 00 - SUBMITTAL PROCEDURES, MANUFACTURERS' FIELD REPORTS article.

1.8 MOCK-UP REQUIREMENTS

- A. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- B. Accepted mock-ups shall be a comparison standard for the remaining Work.
- C. Where mock-up has been accepted by Architect and is no longer needed, remove mock-up and clear area when directed to do so.
- D. Provide a rough in mock-up for both rooms to coordinate all wall mounted outlets and devise connections prior to installation of conduits and outlets.

1.9 TESTING, ADJUSTING, AND BALANCING

- A. Submit, for the User Agency's approval, the name of an independent firm to perform testing, adjusting and balancing of systems. The independent firm's services will be paid for by the Contractor.
- B. The independent firm will perform services specified in individual specifications Sections.
- C. Reports will be submitted by the independent firm to the Design Agent and the User Agency indicating observations and test results, indicating compliance or non-compliance with specified requirements and with the requirements of the Contract Documents.

1.10 REPAIR OF DEFECTIVE CONSTRUCTION

- A. Refer to General Conditions §12. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

- a. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
- b. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
- a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
- c. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
- d. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

1.11 COORDINATION DRAWINGS

- A. Coordination drawings shall include HVAC, Electrical, Plumbing and Fire Protection work and accurately represent the existing conditions to ensure inter-coordination of HVAC, Electrical, Plumbing, Audiovisual, Architectural, Structural, and other work within the limitations of the existing conditions.
- B. The contractor shall create digital coordination drawings suitable modeling software. Prints shall be 3/8" scale. Details of sections and shafts shall be 1/2" scale.
- C. No field installation of HVAC systems shall commence prior to review and approval of the coordination drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 50 00 – TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities:

- a. Temporary electricity.
- b. Temporary lighting for construction purposes.
- c. Temporary heating.
- d. Temporary cooling.
- e. Temporary ventilation.
- f. Telephone service.
- g. Temporary water service.
- h. Temporary sanitary facilities.

B. Construction Facilities:

- a. Field offices and sheds.
- b. Hoisting.
- c. Parking/Traffic.
- d. Project identification.
- e. Traffic regulation.
- f. Independent Food Vendors

C. Temporary Controls:

- a. Barriers.
- b. Enclosures and fencing.
- c. Security.
- d. Fire detection.
- e. Water control.
- f. Dust control.
- g. Erosion and sediment control.
- h. Noise control.
- i. Pest and rodent control.
- j. Pollution control.

D. Removal of utilities, facilities, and controls with reseeding and repair of grounds.

1.2 TEMPORARY ELECTRICITY

- A. The User Agency will pay the cost of energy used. Exercise measures to conserve energy. Utilize the User Agency's existing power service.
- B. Complement the existing power service capacity and characteristics as required for construction operations.
- C. Provide power outlets, with branch wiring and distribution boxes located at each floor or as required for construction operations. Provide flexible power cords as required for portable construction tools and equipment. All flexible power cords shall be suspended with hangers to eliminate trip hazards.

- D. Provide main service disconnect and over-current protection at a convenient location or a feeder switch at the source distribution equipment or meter.
- E. Permanent convenience receptacles may not be utilized during construction.
- F. Provide distribution equipment, wiring, and outlets to provide single-phase branch circuits for power. Provide 20-ampere duplex outlets, single-phase circuits for power tools.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain incandescent lighting for construction (interior & exterior) operations to achieve a minimum lighting level of 2 watt/sq. ft. (21 watt/sq m).
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- C. Maintain lighting and provide routine repairs.
- D. Permanent building lighting may be utilized during construction where not removed.

1.4 TEMPORARY HEATING

- A. Existing facilities will be occupied and heated by the College when temperatures require. Take care to avoid leaving doors open in exterior walls that could compromise heating operations. For new construction, the cost of energy will be borne by the Contractor. Provide temporary heating as necessary for construction operations.
- B. Supplement with temporary heat devices if needed to maintain the specified conditions for construction operations even in existing buildings.
- C. Maintain a minimum ambient temperature of 50 degrees F in the areas where construction is in progress, unless indicated otherwise in the product Sections.
- D. In areas of work with mechanical hot-air heating, clean units and replace filters after Substantial Completion.
- E. Do not use new equipment for heating after replacement during construction.
- F. Provide temporary heating to occupied spaces if construction activities impact normal function of existing systems to occupied spaces. Submit an implementation plan for review and approval by RIC.

1.5 TEMPORARY COOLING

- A. Existing facilities are not available.
- B. Provide and pay for cooling devices and cooling as needed to maintain the specified conditions for construction operations.
- C. Maintain a maximum ambient temperature of 80 degrees F in the areas where construction is in progress, unless indicated otherwise in the specifications.
- D. Provide temporary cooling to occupied spaces if construction activities impact normal function of existing systems to occupied spaces. Submit an implementation plan for review and approval by RIC.

1.6 TEMPORARY VENTILATION

- A. Ventilate the enclosed areas to achieve a curing of materials, to dissipate humidity, and to prevent the accumulation of dust, fumes, vapors, or gases.
- B. If existing ventilation fans are used during construction, clean fans in areas of work after Substantial Completion.

- C. Provide temporary ventilation to occupied spaces if construction activities impact normal function of existing systems to occupied spaces. Submit an implementation plan for review and approval by RIC.

1.7 TELEPHONE SERVICE

- A. Provide, maintain, and pay for cell phone service to the field supervisor at the time of project mobilization.

1.8 TEMPORARY WATER SERVICE

- A. The User Agency will pay the cost of temporary water. Exercise measures to conserve energy. Utilize the User Agency's existing water system, extend and supplement with temporary devices as needed to maintain the specified conditions for construction operations.
- B. Extend branch piping with outlets located so that water is available by hoses with threaded connections. Provide temporary pipe insulation if needed to prevent freezing.

1.9 TEMPORARY SANITARY FACILITIES

- A. Contractor needs to provide and maintain temporary toilet facilities for use by all construction personnel. Trades people will not be permitted to use existing facilities within the building.

1.10 FIELD OFFICES AND SHEDS

- A. Do not use existing facilities for storage. Job meetings will be held on campus at a location to be chosen by the College.
- B. Storage Areas and Sheds: Size to the storage requirements for the products of the individual Sections, allowing for access and orderly provision for the maintenance and for the inspection of Products to the requirements of Section 01 60 00. Containers will be permitted within the project limit line.
- C. Preparation: Fill and grade the sites for the temporary structures to provide drainage away from the buildings.
- D. Removal: At the completion of the Work remove the buildings, foundations, utility services, and debris. Restore the areas.

1.11 HOISTING

- A. Contractor is responsible for all hoisting required to facilitate, serve, stock, clean, and complete the Work. Include all costs for Operating Engineers, fuel, delivery and removal, mobilization, staging, protection of grades and surfaces, and equipment.

1.12 PARKING/TRAFFIC

- A. Workers must park in lots assigned by the College with daily permits. See Site Utilization Plan.
- B. Use of designated existing on-site streets and driveways for construction traffic is permitted. Tracked vehicles are not allowed on paved areas.
- C. Do not allow heavy vehicles or construction equipment in parking areas.
- D. Do not allow vehicle parking on existing sidewalks.
- E. Provide and maintain access to fire hydrants and control valves free of obstructions.
- F. Remove mud from construction vehicle wheels before entering streets. Cleanup dirt, rocks, and debris left on street from construction vehicles.
- G. Use designated existing on-site roads for construction traffic.
- H. Maintenance:

- a. Maintain the traffic and parking areas in a sound condition free of excavated material, construction equipment, products, mud, snow, and ice.
 - b. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain the paving and drainage in original, or specified, condition.
 - c. Plywood and other protections shall be provided when construction equipment is driven over concrete.
- I. Removal, Repair:
- a. Remove temporary materials and at Substantial Completion.
 - b. Remove underground work and compacted materials to a depth of 2 feet; fill and grade the site as specified.
 - c. Repair existing and permanent facilities damaged by use, to the original or specified condition.

1.13 INDEPENDENT FOOD VENDORS

- A. Independent or contracted food vendor trucks are prohibited on Rhode Island College's campus. Contractors are permitted to use college dining facilities (Donovan Dining, Café in Student Union, and The Galley Cafe in Building 3).

1.14 PROJECT IDENTIFICATION

- A. Project Identification Sign: One painted or printed sign, 32 sq ft area, bottom 6 feet above the ground.
- a. Contents:
 - a. Project title, and name of the User Agency as indicated on the Contract Documents.
 - b. Names and titles of the authorities.
 - c. Names and titles of the Design Agent and Consultants.
 - d. Name of the Design Agent Contractor.
 - b. Graphic Design, Colors, and Style of Lettering: 3 colors, as designated by the Design Agent during construction.
- B. Project Informational Signs:
- a. Painted or printed informational signs of same colors and lettering as the Project Identification sign, or standard products; size lettering to provide legibility at 100-foot distance.
 - b. Provide sign at each field office, storage shed, and directional signs to direct traffic into and within site. Relocate as the Work progress requires.
 - c. No other signs are allowed without the User Agency's permission except those required by law.
- C. Design all signs and their structures to withstand a 60-miles/hr-wind velocity.
- D. Sign Painter or Printer: Experienced as a professional sign painter for a minimum of three years.
- E. Finishes, Painting or Printing: Adequate to withstand weathering, fading, and chipping for the duration of construction.
- F. Show content, layout, lettering, color, foundation, structure, sizes, and grades of members.
- G. Installation:
- a. Install the project identification sign within 15 days after the date of receipt of the Purchase Order from State of Rhode Island Department of Administration, Division of Purchases.
 - b. Erect at the designated location.

- c. Erect the supports and framing on a secure foundation, rigidly braced and framed to resist wind loadings.
 - d. Install the sign surface plumb and level, with butt joints. Anchor securely.
 - e. Paint exposed surfaces of the sign, supports, and framing.
- H. Maintenance: Maintain the signs and supports clean, repair deterioration and damage.
- I. Removal: Remove the signs, framing, supports, and foundations at the completion of the Project and restore the area.

1.15 TRAFFIC REGULATION

- A. Signs, Signals, And Devices:
- a. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As approved by local jurisdictions.
 - b. Traffic Cones and Drums, Flares and Lights: As approved by local jurisdictions.
 - c. Flag person Equipment: As required by local jurisdictions.
 - d. Police Details: Provide all police details as required by local jurisdictions, including payment directly to applicable jurisdiction.
 - e. On Campus Police Details: The User Agency shall provide and over costs for details provided by RIC Campus Police. If RIC is unable to provide, contractor shall provide flaggers and will be compensated for the flagger's hours.
- B. Flag Persons: Provide trained and equipped flag persons to regulate the traffic when construction operations or traffic encroach on the public traffic lanes.
- C. Flares and Lights: Use flares and lights during the hours of low visibility to delineate the traffic lanes and to guide traffic.
- D. Haul Routes:
- a. Consult with the authority having jurisdiction, establish the public thoroughfares to be used for haul routes and site access.
- E. Traffic Signs and Signals:
- a. At approaches to the site and on site, install at crossroads, detours, parking areas, and elsewhere as needed to direct the construction and affected public traffic.
 - b. Install and operate automatic traffic control signals to direct and maintain the orderly flow of traffic in areas under the Contractor's control, and areas affected by the Contractor's operations.
 - c. Relocate as the Work progresses, to maintain effective traffic control.
- F. Removal:
- a. Remove equipment and devices when no longer required.
 - b. Repair damage caused by installation.
 - c. Remove post settings to a depth of 2 feet.

1.16 BARRIERS

- A. Provide barriers to allow for the User Agency's use of the site and to protect existing facilities and adjacent properties from damage from the construction operations, or demolition.
- B. Provide barricades and covered walkways required by RIC for public rights- of-way, or for public access to the building.
- C. Provide protection for plants designated to remain. Replace damaged plants.

- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.17 ENCLOSURES AND FENCING

- A. Exterior: Contractor shall provide 6-ft. high commercial grade chain link fence that is properly secured and maintained around the building and/or site in order to protect the public and the work. Include in the Site Plan the location of the fence and pedestrian and vehicular gates for User Agency review. Access shall be available to all egress doors as designated by the User Agency.
- B. Contractor shall be responsible for providing, installing and maintaining visual screening on fence using printed fabric. Fabric and graphics shall be approved by the User Agency.
- C. Equip fencing with vehicular and pedestrian gates with locks. Provide two set of keys to all gates and door locks to the User Agency.
- D. Perform adjustment to the proposed layout as may be directed by the User Agency.
- E. Contractor to provide overhead cover protection at all entrances and egresses from the building. Entrances and paths of egress must be clearly marked with signage with placement and language approved in advance by the User Agency.
- F. Staging of equipment, dumpsters and materials must be situated within the project fenced-in areas.
- G. Interior Enclosures:
 - a. Provide temporary partitions and ceilings as indicated to separate the work areas from User Agency-occupied areas, to prevent penetration of dust and moisture into User Agency-occupied areas, and to prevent damage to the existing materials and equipment.
 - b. Construction: Framing and reinforced polyethylene, plywood, or gypsum board sheet materials with closed joints and sealed edges at intersections with existing surfaces, as agreed with the User Agency: Maximum flame spread rating of 75 in accordance with ASTM E84.

1.18 SECURITY

- A. Security Program:
 - a. Protect the Work, the existing premises, or the User Agency's operations from theft, vandalism, and unauthorized entry.
 - b. Initiate the program in coordination with the User Agency's existing security system at mobilization.
 - c. Maintain the program throughout the construction period until User Agency occupancy of each designated area.
- B. Entry Control: Coordinate the access of the User Agency's personnel to the site in coordination with the User Agency's security forces. The Contractor is responsible for providing adequate locks for the site and furnish the requested quantities of keys to the User Agency.

1.19 FIRE DETECTION

- A. Before beginning any construction operation that can potentially trigger the existing fire alarm detection system, notify the User Agency through use of the form provided in Section 01 10 00.
- B. Failure to so notify the User Agency will subject the Contractor to a monetary fine for each occurrence, should the fire detection system be activated inadvertently by a construction activity.
- C. Comply with the User Agency's insurance underwriting standards and insurer recommendations for Hot Work, sprinkler impairment, and site maintenance.

1.20 WATER CONTROL

- A. Grade the site to drain. Maintain excavations free of water. Provide, operate, and maintain the pumping equipment.
- B. Protect the site from puddling or running water. Provide water barriers as required to protect the site from soil erosion.

1.21 DUST CONTROL

- A. Execute the Work by methods to minimize raising dust from construction operations.
- B. Provide positive means to prevent air-borne dust from dispersing into the atmosphere.

1.22 EROSION AND SEDIMENT CONTROL

- A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize the amount of bare soil exposed at one time.
- C. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
- D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
- E. Periodically inspect the earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.
- F. Follow Rhode Island DEM Soil Stabilization Requirements, including, but not limited to:
 - a. Stabilizations of disturbed areas must, at a minimum, be initiated immediately whenever any clearing, grading, excavating or other earth disturbance activities have permanently ceased on any portion of the site, or temporarily ceased on any portion of the site and will not resume for a period exceeding fourteen (14) calendar days.
 - b. Stabilization must be completed using vegetative stabilization measures or using alternative measures whenever vegetative measures are deemed impracticable or during periods of drought.
 - c. All disturbed soils exposed prior to October 15th shall be seeded by that date.
 - d. Any such areas which do not have adequate vegetative stabilization by November 15th must be stabilized through the use of non-vegetative erosion control measures.
 - e. If work continues within any stabilized areas during the period from October 15th through April 15th, care must be taken to ensure that only the area required for that day's work is exposed, and all erodible soil must be stabilized within five (5) working days.

1.23 CLEANING

- A. Refer to Section 01 74 13 – Cleaning. Contractor to maintain a neat and orderly work site. Trash shall be cleaned from site and surrounding area on a daily basis.
- B. For projects within occupied buildings, contractor shall sweep and wet mop all floors on a daily basis for impacted spaces. Surfaces of desks, tables, etc. shall be covered during construction and cleaned of dust and debris.

1.24 NOISE CONTROL

- A. Provide methods, means, and facilities to minimize noise produced by the construction operations.

1.25 PEST AND RODENT CONTROL

- A. Provide methods, means, and facilities to prevent pests, insects and rodents from damaging the Work, or accessing or invading the facility.

1.26 POLLUTION CONTROL

- A. Provide methods, means, and facilities to prevent the contamination of soil, water, and the atmosphere from discharge of noxious, toxic substances, and pollutants produced by the construction operations.

1.27 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, and materials, prior to Substantial Completion.
- B. Remove the underground installations to a minimum depth of 2 feet. Grade the site as indicated.
- C. Clean and repair the damage caused by installation or use of temporary work.
- D. Restore the existing and new facilities used during construction to their original condition.
- E. Restore any temporary exterior laydown or storage areas to the original condition. After each use, regrade and reseed as required to meet this requirement.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 60 00 – PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Products.
- B. Product delivery requirements.
- C. Product storage and handling requirements.
- D. Product options.
- E. Product substitution procedures.

1.2 PRODUCTS

- A. Products: Means new material, machinery, components, fixtures, or systems forming the Work; but does not include the machinery or equipment used for the preparation, fabrication, conveying, or erection of the Work. Products may include the existing materials or components required or specified for reuse.
- B. Furnish products of qualified manufacturers suitable for the intended use. Furnish products of each type by a single manufacturer unless specified otherwise.
- C. Do not use materials and equipment removed from the existing premises, except as specifically permitted by the Contract Documents.
- D. Furnish interchangeable components of the same manufacturer for the components being replaced.

1.3 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with the manufacturer's instructions.
- B. Promptly inspect shipments to ensure that the products comply with the requirements, the quantities are correct, and the products are undamaged.
- C. Provide equipment and personnel to handle the products by methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect the products in accordance with the manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to the product.
- D. For exterior storage of fabricated products, place on sloped supports above the ground.
- E. Provide bonded off-site storage and protection when the site does not permit on-site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent the condensation and degradation of products.
- G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store the products by methods to prevent soiling, disfigurement, or damage.

- I. Arrange storage of the products to permit access for inspection. Periodically inspect to verify that the products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any Product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of one of the manufacturers named and meeting the 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 in accordance with the following article.

1.6 PRODUCT SUBSTITUTION PROCEDURES

- A. Instructions to Bidders specify the time restrictions for submitting requests for Substitutions during the bidding period to requirements specified in this section.
- B. Substitutions may be considered after the bid only in the following circumstances:
 - a. When a product becomes no longer in production following the date of receipt of the Purchase Order for this Contract. Submit certification both that specified product was carried in Bid, and is no longer obtainable. Provide cost change documentation.
 - b. There is a significant cost savings offered to the User Agency. Provide price comparison of both bid and offered substitution products as well as all collateral costs of the change.
 - c. Code changes or site conditions require a different item from that bid. Submit as for 2 above.
- C. Document each request with complete data substantiating the compliance of a proposed Substitution with the Contract Documents.
- D. A request constitutes a representation that the Bidder:
 - a. Has investigated the proposed Product and determined that it meets or exceeds the quality level of the specified product.
 - b. Will provide the same warranty for the Substitution as for the specified Product.
 - c. Will coordinate the installation and make changes to other Work which may be required for the Work to be complete with no additional cost to the User Agency, including redesign.
 - d. Waives claims for additional costs or time extension which may subsequently become apparent.
 - e. Will reimburse the User Agency and the Design Agent for review or redesign services, including those associated with re-approval by the authorities having jurisdiction.
- E. Substitutions will not be considered when they are indicated or implied on the Shop Drawing or Product Data submittals, without a separate written request, or when acceptance will require revision to the Contract Documents.
- F. Substitution Submittal Procedure, If Permitted Following Contract Award:
 - a. Submit three copies of a request for Substitution for consideration, no later than 20 working days following date of receipt of the Purchase Order for this Contract. Limit each request to one proposed Substitution. Identify product of fabrication or installation method to be replaced. Include Specification Section number and title and Drawing number and title.
 - b. Submit the Shop Drawings, Product Data, and the certified test results attesting to the proposed product equivalence. The burden of proof is on the proposer.
 - c. The Design Agent will notify the Contractor in writing of a decision to accept or reject the request. Costs for review time on unsuccessful requests will be included in the next change order.

PART 2 - PRODUCTS

- A. No variations in this section for this Project.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

01 71 00 – EXAMINATION, PREPARATION AND EXECUTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Examination & preparation.
- B. Field engineering.
- C. Protection of adjacent construction.
- D. Protecting installed construction.
- E. Materials used in cutting and patching.
- F. Preparation of cutting and patching.
- G. Special procedures.
- H. Selective demolition.
- I. Cutting and patching.

1.2 EXAMINATION & PREPARATION

- A. Acceptance of Conditions:
 - a. Verify that existing applicable site conditions, substrates, or substrate surfaces are acceptable or meet specific requirements of individual specifications Sections, for subsequent Work to proceed.
 - 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 specifications Sections.
 - d. Verify that utility services are available, of correct characteristics, and in correct locations.
 - e. Beginning of new Work, which relies upon the quality and proper execution of Work of a preceding trade, means acceptance of that preceding Work as appropriate for the proper execution of subsequent Work.
 - f. Acceptance of preceding Work that can be shown later to have adversely affected proper performance of new Work may result in removal and repeat performance of all Work involved at no cost to the User Agency.
- B. Clean substrate surfaces prior to applying next material or substance.
- C. Seal cracks or openings of substrate prior to applying next material or substance.
- D. Apply substrate primer, sealer, or conditioner, required or recommended by manufacturer, prior to applying any new material or substance in contact or bond.
- E. Prior to the application, installation, or erection of any products and product components, perform any other preparatory operations, or surface or substrate modifications, as may be specified or directed by product manufacturers.

1.3 FIELD ENGINEERING

- A. Employ a Land Surveyor registered in the State of Rhode Island and acceptable to Design Agent and the User Agency.
- B. Locate and protect survey control and reference points. Promptly notify Design Agent of any discrepancies discovered.

- C. Control Datum for survey is to be agreed to with the Design Agent.
- D. Verify setbacks and easements, if any; confirm drawing dimensions and elevations.
- E. Provide field-engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.
- F. Submit a copy of site drawings and certificate signed by the Land Surveyor that the elevations and locations of the Work are in conformance with the Contract Documents.
- G. Maintain a complete and accurate log of control and survey work as it progresses.
- H. If required by the User Agency, on completion of foundation walls and major site improvements, prepare a certified survey illustrating dimensions, locations, angles, and elevations of construction and site work.
- I. Protect survey control points prior to starting site work; preserve permanent reference point during construction.
- J. Promptly report to Design Agent the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
- K. Replace dislocated survey control point based on original survey control. Make no changes without prior written notice to Design Agent.
- L. Establish horizontal datum lines that are critical to achieve the alignments of façade elements as indicated on the drawings.

1.4 PROTECTION OF ADJACENT CONSTRUCTION

- A. Protect existing adjacent properties and provide special protection where specified in individual Specification Sections.
- B. Provide protective coverings at wall, projections, jambs, sills, and soffits of existing openings.
- C. Protect existing finished floors, stairs, and other existing surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- D. Cover and protect furnishings, materials and equipment within the spaces receiving new work. Move items as necessary to install new work and return them to original locations at the close of construction in that area.
- E. Repair adjacent properties damaged by construction operations to original condition to the satisfaction of the User Agency.
- F. Prohibit unnecessary traffic from existing landscaped areas.

1.5 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections.
 - a. IT wires shall not be painted. IT wires, faceplates, racks and other components shall be fully protected during painting activities. IT wires which have been painted or exposed to paint splatter shall be replaced and terminated at no cost to the User Agency upon request.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Repair or replace installed Work damaged by construction operations, as directed by the Design Agent.

PART 2 - PRODUCTS

2.1 MATERIALS USED IN CUTTING AND PATCHING

- A. Unless otherwise indicated, the Contractor shall provide materials for cutting and patching which will result in an equal-or-better product than the material being cut and patched, in terms of performance characteristics and including visual effects where applicable. The Contractor shall use material identical with the original materials where feasible.
- B. Match existing materials unless otherwise specified.
- C. Restore Work with new Products in accordance with requirements of Contract Documents.
- D. Materials shall comply with the requirements of the Technical Specifications found in individual Sections; match existing with new products, or salvaged products as appropriate, for patching and extending work.
- E. Provide submittals for approval to the Design Agent and User Agency.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor shall provide adequate temporary support for Work to be cut to prevent failure
- B. The Contractor shall provide adequate protection of other Work during cutting and patching.
- C. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
- D. Identify any hazardous substance or conditions exposed during the Work to the User Agency and Design Agent for decision or remedy.
- E. By careful study of the Contract Documents, determine the location and extent of selective demolition and repairs to be performed.

3.2 SPECIAL PROCEDURES

- A. The Contractor shall use methods least likely to damage Work to be retained and Work adjoining. Provide proper surfaces to receive patching and finishing.
- B. Where physical cutting action is required, the Contractor shall cut Work with sawing and grinding tools, not with hammering and chopping tools. Openings through concrete Work shall be core-drilled or using a masonry saw.
- C. Remove ceiling tiles as necessary to access areas of work. Store and replace carefully to avoid damage. Replace all ceiling tiles damaged during the work with new tiles to match. Repair ACT grid damaged during the work in accordance with this section.
- D. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.
- E. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- F. At penetration of fire rated partitions, ceiling, or floor construction, completely seal voids with fire rated or fire resistant material in accordance with Specifications, to full thickness of the penetrated element.
- G. All demolition work shall be carried on in such a manner that the existing building and site and their component parts will not be damaged. Any damage to the building shall be corrected by the Contractor, to the satisfaction of the User Agency and Architect, at no additional cost to the User Agency.

- H. Close openings in exterior surfaces to protect existing Work from weather and extremes of temperature and humidity.
- I. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.

3.3 SELECTIVE DEMOLITION

- A. Carefully demolish and remove from the building and site those items specified to be demolished and removed.
- B. Remove, cut, modify and patch as necessary to conduct Work in a manner to minimize damage and to provide means of restoring products and finishes to original or specified condition. Replace and restore at completion.
- C. Prepare and follow an organized plan for demolition and removal of items:
 - a. Shut off, cap, and otherwise protect existing utility lines.
 - b. Completely remove items scheduled to be so demolished and removed, leaving surfaces clean, solid, and ready to receive new materials specified elsewhere.
 - c. Where indicated on the drawings, completely remove footings, foundations, and aboveground and under-ground construction of all kinds.
 - d. For projects involving excavation, remove rocks larger than 6" diameter, roots, and debris.
- D. Remove unsuitable material not marked for salvage, such as rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.
- E. Remove debris and abandoned items from area and from concealed spaces.
- F. The Contractor shall be responsible for the removal and disposal of all materials and equipment from the site and building during the project. Unless directed otherwise by the User Agency, all demolition materials to be removed from the site shall be disposed of in accordance with applicable laws and regulations. **User Agency shall have first right of refusal of any and all materials and equipment scheduled for removal.**
- G. In the event of demolition of items not so scheduled to be demolished, promptly replace such items to the approval of the Architect and at no additional cost to the User Agency.

3.4 CUTTING AND PATCHING

- A. Provide patching and repairs to all surfaces as indicated and as required for a complete and proper job, including all surfaces damaged as a result of the work of this Contract. Patch or replace portions of existing surfaces which are damaged, or shows imperfections not acceptable to the Design Agent or User Agency.
- B. Employ skilled and experienced installers to perform cutting and patching.
- C. Submit written request in advance of cutting or altering elements which affect:
 - a. Structural integrity of element.
 - b. Integrity of weather-exposed or moisture-resistant elements.
 - c. Efficiency, maintenance, or safety of element.
 - d. Visual qualities of sight-exposed elements.
 - e. Existing construction, or Work of separate contractor.
- D. Execute cutting, fitting, and patching including excavation and fill, to complete Work, and to:
 - a. Fit the several parts together, to integrate with other Work.
 - b. Uncover Work to install or correct ill-timed Work.

- c. Remove and replace defective and non-conforming Work.
 - d. Remove samples of installed Work for testing.
 - e. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- E. Execute Work by methods that will avoid damage to other Work, and provide proper surfaces to receive patching and finishing.
- F. Cut masonry, concrete, and other rigid materials using masonry saw or core drill.
- G. Remove ceiling tiles as necessary to access areas of work. Store and replace carefully to avoid damage. Replace all ceiling tiles damaged during the work with new tiles to match. Repair ACT grid damaged during the work in accordance with this section.
- H. Restore Work with new Products in accordance with requirements of Contract Documents.
- I. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.
- J. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- K. At penetration of fire rated partitions, ceiling, or floor construction, completely seal voids with fire rated or fire resistant material in accordance with Specifications, to full thickness of the penetrated element.
- L. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit. Ensure a neat transition to adjacent finishes
- M. Identify any hazardous substance or conditions exposed during the Work to the Owner and Design Agent for decision or remedy.
- N. Prepare surface and remove surface finishes to provide installation of new Work and finishes.
- O. When completed, patches or repairs shall not be visible to the naked eye from a distance of 6 feet.
- P. Exterior Patching
 - a. Any damage to buildings, roads, public roads, bituminous concrete areas, fences, lawn areas, trees, shrubbery, poles, underground utilities, etc. shall be made good by and at the Contractor's own expense, all to the satisfaction of the User Agency.
 - b. The Contractor shall patch, repair and/or replace all adjacent materials and surfaces damaged after the installation of new work at no expense to the User Agency. All repair and replacement work shall match the existing in kind and appearance.
 - c. Restore grassed landscaped areas damaged by construction operations to full healthy growth, by installing loam and sod to the requirements, and under the supervision of the user agency.
- Q. See General Conditions for additional requirements.

END OF SECTION

01 74 13 – CLEANING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning requirements during construction operations.
- B. Final cleaning prior to turning the project over to the User Agency.
- C. Scope
- D. Related Documents
- E. Quality
- F. Contractor's Failure to Clean
- G. Cleaning Materials
- H. Construction in an Occupied Building
- I. Process Cleaning During Cleaning
- J. Final Cleaning

1.2 SCOPE

- A. This section specifies the requirements for maintaining a clean and orderly work site during and at the completion of the Work.
- B. Pay special attention to work areas that affect occupied spaces and public areas.

1.3 RELATED DOCUMENTS

- A. This section supplements Article 4.17 of the General Conditions.
- B. Consult the individual sections of the specifications for cleaning of Work installed under those sections.
- C. Cutting and Patching: Section 01 73 29.
- D. Pest Control: Comply with pest control requirements in Section 01 50 00.
- E. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 74 19.

1.4 QUALITY

- A. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
- B. Conduct all cleaning and disposal operations to comply with all federal, state, and local laws, regulations, codes, ordinances and by-laws.
 - a. Do not burn or bury rubbish and waste materials on the site.
 - b. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
 - c. Do not dispose of wastes into streams or waterways.
- C. In cleaning items with manufacturer's finish or items previously finished by a Subcontractor, care shall be taken not to damage such manufacturer's or Subcontractor's finish Any damage to finishes caused by cleaning operations shall be repaired at the Contractor's expense.

1.5 CONTRACTOR'S FAILURE TO CLEAN

- A. If the Contractor fails to maintain levels of cleanliness in work areas, satisfactory to the User Agency, then the User Agency shall have the right to cause such areas to be cleaned by others. The costs to the User Agency for such cleaning, plus 25% for administration, shall be the obligation of the Contractor and shall be deducted from any money due the Contractor hereunder.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned.
- B. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
 - a. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 CONSTRUCTION IN AN OCCUPIED BUILDING

- A. Efforts must be taken to limit dust, noise and odors from escaping the work area. Proper separation and protection of interior spaces shall be established and maintained during the project, to the satisfaction of the User Agency. Contractor shall provide and maintain walk-off mats and plastic barriers at work site entries.
- B. Contractor shall provide appropriate masking of building supply air intakes to protect indoor air quality and limit transfer of odors. Contractor to provide air scrubbing and/or negative air machines to prevent odors from escaping the Project Site.
- C. Do not leave debris, tools or materials in occupied areas.
- D. Immediately following the completion of Work in an occupied area, Contractor shall pick up and stow all equipment and miscellaneous material leaving the site in a neat and safe condition.
 - a. Occupied spaces must be returned to original conditions to the greatest extent possible by 8am weekdays. If it is not feasible to do as such, notify the User Agency immediately. With approval, the area shall be cordoned off with cones and caution tape and computer generated signage shall be posted to the satisfaction of the User Agency.
- E. Contractor shall ensure that horizontal and vertical surfaces in the occupied areas in the building impacted by construction activities are thoroughly vacuumed, wet mopped and cleaned to the satisfaction of the User Agency at the end of each shift, or upon request.

3.2 PROGRESS CLEANING DURING CONSTRUCTION

- A. Maintain areas under Contractor's control (including employee parking and Contractor's staging areas) free of waste materials, scraps, surplus material, debris and rubbish. Maintain site in a clean and orderly condition.
- B. Clean interior areas daily to provide suitable conditions for Work and to prevent fire or accidents. Sufficient time to clean up work zones shall be allocated at the end of the shift.
- C. All combustible waste materials shall be removed from buildings at the end of each working day.
- D. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

- E. Vacuum clean interior building areas when ready to receive finish painting, and continue vacuum cleaning on an as-needed basis until Substantial Completion.
- F. Waste Management
 - a. Collect and remove waste materials, debris, and rubbish from the site daily, as necessary to prevent an on-site accumulation of waste material, debris, and rubbish, and dispose off-site.
 - b. Remove debris and rubbish from pipe chases, plenums attics, crawl spaces and other closed or remote spaces, prior to closing the space.
 - c. Maintain the Site free from accumulations of waste, debris, and rubbish.
 - d. Do not allow materials and rubbish to drop free or be thrown from upper floors, but remove by use of a material hoist or rubbish chutes.
 - e. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.
 - f. Provide on-site containers for collection of waste materials and rubbish.
- G. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.
- H. Broom clean interior areas prior to start of surface finishing and continue cleaning on a daily basis.
- I. Control cleaning operations so that dust and other particulates will not adhere to wet or newly-coated surfaces. Responsibility for construction cleaning shall not be delegated to subcontractors performing construction work under this Contract.
- J. Clean as required to ensure proper and lasting installation of equipment and finishes.

3.3 FINAL CLEANING

- A. Unless otherwise specified under other sections of the Specifications, the Contractor shall perform final cleaning operations as herein specified prior to final inspection.
- B. Cleaning shall include all surfaces, interior and exterior, which the Contractor has had access to, whether new or existing.
- C. Remove grease, mastic, adhesive, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior surfaces. This includes cleaning of the Work of all finishing trades where needed, whether or not cleaning by such trades is included in their respective specifications. Remove labels that are not permanent.
- D. Repair, patch, and touch up marred surfaces to the specified finish, to match adjacent surfaces.
- E. Polish glossy surfaces to a clear shine.
- F. Site & Exteriors
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - d. Remove all cigarette buds and other litter.
- G. Remove excess materials
 - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - b. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

- c. Remove all attic stock (extra materials) from the building and transmit per the User Agency's directive.
- H. Interiors
 - a. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - b. Sweep concrete floors broom clean in unoccupied spaces.
 - c. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - d. Final Cleaning of resilient floors and wood floors shall be as specified under the respective sections of the Specifications.
 - e. Leave all architectural metals, hardware, and fixtures in undamaged, polished conditions.
- I. Glass
 - a. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - b. Clean plastic glazing in accordance with the manufacturer's directions.
 - c. In cleaning glass and finish surfaces, care shall be taken not to use detergents or other cleaning agents which may stain adjoining finish surfaces.
 - d. All broken or defective glass caused by the Contractor's Work shall be replaced at the expense of the Contractor.
- J. Cleaning of MEP Equipment
 - a. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - b. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - c. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - d. Clean ducts, blowers, and coils if units were operated during construction or that display contamination with particulate matter on inspection.
 - e. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - f. Leave pipe and duct spaces, plenums, furred spaces and the like clean of debris and decaying materials.
- K. Prior to submitting a request to the Architect to certify Substantial Completion of the Work, the Contractor shall inspect all interior and exterior spaces and verify that all waste materials, rubbish, tools, equipment, machinery, and surplus materials have been removed, and that all sight-exposed surfaces are clean. Leave the Project clean and ready for occupancy.
- L. User Agency's responsibility for cleaning commences at occupancy, however Contractor shall provide satisfactory cleaning as requested or required as a result of Contractor activity in the project area or occupied spaces. .

END OF SECTION

01 74 19 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Waste Management Requirements
- B. Related Requirements
- C. Definitions
- D. Submittals
- E. Waste Management Procedures
- F. Waste Management Implementation

1.2 WASTE MANAGEMENT REQUIREMENTS

- A. User Agency requires that this project generate the least amount of trash and waste possible.
- B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
- C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
- D. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
 - a. Aluminum and plastic beverage containers.
 - b. Corrugated cardboard.
 - c. Wood pallets.
 - d. Clean dimensional wood: May be used as blocking or furring.
 - e. Land clearing debris, including brush, branches, logs, and stumps.
 - f. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
 - g. Glass.
 - h. Gypsum drywall and plaster.
 - i. Plastic buckets.
 - j. Paper, including wrapping, newsprint, and office.
- E. Contractor shall submit monthly Waste Disposal Reports; all landfill disposal, incineration, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports. Submit in accordance with Section 01 33 00.
- F. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.
- G. Methods of trash/waste disposal that are not acceptable are:
 - a. Burning on the project site.
 - b. Burying on the project site.
 - c. Dumping or burying on other property, public or private.
 - d. Other illegal dumping or burying.

- H. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.3 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.
- B. Section 01 50 00 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.
- C. Section 01 60 00 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.
- D. Section 01 70 00 - Execution Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.
- E. Section 01 74 13 – Cleaning
- F. Section 01 81 13 - Sustainable Design Requirements

1.4 DEFINITIONS

- A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.
- B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.
- C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.
- D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.
- E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
- H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- I. Return: To give back reusable items or unused products to vendors for credit.
- J. Reuse: To reuse a construction waste material in some manner on the project site.
- K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
- M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
- O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

- P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.5 SUBMITTALS

- A. See Section 01 33 00 for submittal procedures.
- B. Waste Management Plan: Include the following information:
- a. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
 - b. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).
 - c. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
 - d. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
 - e. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
 - f. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.
- C. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
- a. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
 - b. Submit Report on a form acceptable to User Agency.
 - c. Landfill Disposal: Include the following information:
 - a. Identification of material.
 - b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
 - c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 - d. Incinerator Disposal: Include the following information:
 - a. Identification of material.
 - b. Amount, in tons or cubic yards, of trash/waste material from the project delivered to incinerators.
 - c. State the identity of incinerators, total amount of fees paid to incinerator, and total disposal cost.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 - e. Recycled and Salvaged Materials: Include the following information for each:
 - a. Identification of material, including those retrieved by installer for use on other projects.
 - b. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
 - c. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.

- d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
- e. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
- f. Material Reused on Project: Include the following information for each:
 - a. Identification of material and how it was used in the project.
 - b. Amount, in tons or cubic yards.
 - c. Include weight tickets as evidence of quantity.
- g. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 WASTE MANAGEMENT PROCEDURES

- A. See Section 01 10 00 for list of items to be salvaged from the existing building for relocation in project or for User Agency.
- B. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.
- C. See Section 01 50 00 for additional requirements related to trash/waste collection and removal facilities and services.
- D. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.
- E. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

3.2 WASTE MANAGEMENT IMPLEMENTATION

- A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.
- B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, User Agency, User Agency's Recycling and Solid Waste Coordinator, and Design Agent.
- C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.
- D. Meetings: Discuss trash/waste management goals and issues at project meetings.
 - a. Pre-bid meeting.
 - b. Pre-construction meeting.
 - c. Regular job-site meetings.
- E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
 - a. Provide containers as required.
 - b. Provide adequate space for pick-up and delivery and convenience to subcontractors.
 - c. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.
- F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

- G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.
- H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.
- I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION

01 78 00 – CLOSEOUT PROCEDURES AND SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Related Requirements
- B. Definitions
- C. Quality Assurance
- D. Starting And Adjusting of Systems
- E. Demonstration and Instructions
- F. Substantial Completion
- G. Spare Parts and Maintenance Products
- H. Product Warranties and Product Bonds
- I. Emergency Contacts List
- J. Final Completion
- K. Maintenance Service
- L. Project Turnover
- M. Mark-up Set of Construction Documents
- N. Administrative Closeout
- O. Owner's Manual
- P. Project Record Documents
- Q. Final Application for Payment.

1.2 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Individual Product Sections: Specific requirements for operation and maintenance data.
- C. Individual Product Sections: Warranties required for specific products or Work.

1.3 DEFINITIONS

- A. Substantial Completion: refer to General Conditions A201 §9.8.1.
- B. Project Closeout is the period of time after the Substantial Completion date until the Contractor, Design Agent and User Agency have completed all contract items, closeout obligations, and processed final payment. This time period may overlap a portion of the warranty period.
- C. Warranty period is one year from the Substantial Completion date, unless specified otherwise. Individual products and work performed may have longer specific warranty periods as outlined in the Certificate of Substantial Completion. The warranty period may also be referred to as "Post Construction Phase".

1.5 QUALITY ASSURANCE

- A. Employ personnel assembling submittals experienced in the maintenance and the operation of the described products and systems.

1.6 STARTING AND ADJUSTING OF SYSTEMS

- A. Coordinate schedule for starting and adjusting of various equipment and systems.
- B. Notify Design Agent and User Agency seven days prior to starting and adjusting of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
- D. Verify that tests, meter readings and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute starting and adjusting under supervision of responsible Contractor's personnel or manufacturer's representative, in accordance with manufacturer's instructions.
- G. Adjust operating Products and equipment to ensure smooth and unhindered operation.
- H. When specified in individual specifications Section, require manufacturer to provide authorized representative to be present at the site to inspect, check, and approve equipment or system installation prior to starting, and to supervise placing of equipment or system in operation.
- I. Submit a written report in accordance with Section 01 40 00 that equipment or system has been properly installed and is functioning correctly.

1.7 DEMONSTRATION AND INSTRUCTIONS

- A. Provide training and demonstrations of the equipment and sequences of systems operation to User Agency's personnel two weeks prior to date of Substantial Completion.
- B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- C. Training and demonstrations to include the following in conjunction with designated Operations personnel:
 - a. Operate the equipment and systems for a minimum of two hours or five repetitions, or as otherwise required. If problems occur, correct them and repeat the full demonstration.
 - b. Demonstrate proper equipment and systems operation, as well as procedures for cleaning, lubrication, maintenance, replacement of routine expendable parts and all other actions required for normal operations and maintenance.
 - c. Demonstrate and review both normal and failure modes of system controls operation where they are designed as such.
 - d. Review O&M manuals
 - e. Place systems into full operation
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manuals with User Agency's personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled or agreed upon times, at equipment or system location.

- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. For each training session, Contractor shall provide written verification of training including, date, time, name of trainer, systems demonstrated, and agenda. Contractor shall prepare and submit a sign in sheet with name, email, title, phone number and signature of all attendees. This shall be turned over as part of the closeout package.

1.8 SUBSTANTIAL COMPLETION

- A. Refer to General Conditions §9.8 Substantial Completion for more information.
- B. The User Agency will occupy all portions of the building after Substantial Completion as specified in Section 01 10 00.
- C. Per RI General Laws § 37-12-10.1, Contractor shall notify User Agency and Design Agent that work is considered substantially complete utilizing the format indicated in the statute. A walk-through inspection for determining the date of Substantial Completion will be scheduled. Prior to the request, the following items shall be completed:
 - a. All security, network and telecommunications and door access shall be complete.
 - b. Complete startup and testing of mechanical, electrical and plumbing systems.
 - c. Completion of Demonstration and Instructions
 - d. Contractor shall prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete. The Design Agent shall review and perform an inspection
 - e. Testing and balance reports are available.
 - f. Request and complete commissioning and inspection.
 - g. Deliver tools, spare parts, extra materials, and similar items to location designated by User Agency, per requirements, below.
 - h. Make final changeover of permanent locks and deliver keys and keying schedule to User Agency. Advise User Agency's personnel of changeover in security provisions.
 - i. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - j. Submit changeover information related to heat and other utilities, and User Agency's occupancy, use, operation, and maintenance.
 - k. Complete final cleaning requirements, including touchup painting.
 - l. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
 - m. Obtain and submit releases permitting User Agency unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
- D. Following demonstration of compliance with the items above, and as stipulated in RI General Laws § 37-12-10.1, Design Agent shall prepare a Certificate of Substantial Completion. At such time, Contract may submit an Application for Payment releasing held retainage.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Furnish spare parts, maintenance, and extra products (attic stock) in the quantities specified in the individual specification Sections.
- B. Deliver to the Project site and place in a location as directed by the User Agency; obtain a receipt prior to final payment.
- C. See Owner's Manual, below, on submission of documentation.

1.11 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Warranty period shall commence at date of substantial completion.
- B. 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 User Agency's permission, leave date of beginning of time of warranty until the Date of Substantial completion is determined.
- C. Retain warranties and bonds until time specified for submittal.
- D. Execute and assemble the transferable warranty documents and bonds from the subcontractors, suppliers, and manufacturers.
- E. Verify that the documents are in the proper form, contain full information, and are notarized.
- F. Include in the Operations and Maintenance Manuals within the appropriate material specification section, indexed separately on Table of Contents.
- G. Closeout Submittals Warranties and Bonds:
 - a. For equipment or component parts of equipment put into service during construction with User Agency's permission, submit documents within 10 days after acceptance.
 - b. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - c. 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.
- H. See §3.3 Owner's Manual, below, on submission of documentation. At Final Completion of all work as certified by the College and Architect/Engineer, the Contractor shall deliver a Letter of Warranty to the College. This Warranty certifies that the Contractor shall promptly replace or repair any defects in equipment, materials or workmanship that becomes apparent within one (1) year from the date of Final Completion, or the College's acceptance of the Project, whichever is later.
- I. The Warranty shall include repairs and corrections to pipe covering, paint, woodwork, or any other material and equipment caused to be imperfect due to defective workmanship or materials. All direct and consequential repairs shall be entirely at the expense of the Contractor.
- J. Additional manufacturers' extended warranties for major equipment shall be supplementary to this guarantee.

1.13 EMERGENCY CONTACT LIST:

- A. Construction Contacts:
 - a. During the course of construction, the Contractor shall supply a telephone number that the College may call on a twenty-four (24) hour/day basis for emergency repairs or service made necessary because of Contract work in progress.
 - b. Coordinate with the Project Manager to complete and file form with Facilities Service Response Center.
- B. Warranty Period Contacts:
 - a. Provide a telephone number that the College may call on a twenty-four (24) hour/day basis to receive immediate repairs and service, during the Warranty period. If the College is unable to contact the Contractor to obtain service, the College shall arrange for service from another service provider or College employees and shall charge the expenses to the Contractor.

1.14 FINAL COMPLETION

- A. Refer to General Conditions Article 9.10 Substantial Completion for more information.
- B. In order for Final Payment to be accepted, the following must be complete:
 - a. Resolution of all outstanding punch list items
 - b. Final inspection of the project by the User Agency, Design Agent and Contractor
 - c. Final inspections and certifications from authorities having jurisdiction.
 - d. Acceptance of all Closeout Documentation (See Part 3 – Execution for Details).
 - a. Administrative Closeout
 - b. Owner's Manual
 - c. Project Record Documents
 - d. Final Application for Payment

1.15 PROJECT TURNOVER:

- A. Sign off of the punch list is required for approval of the final Application for Payment.
- B. At the time of Substantial Completion, the Contractor shall coordinate with the College's Project Manager to schedule a project turnover meeting. This meeting shall include the College's Project Manager, Contractor, Sub-Contractors, Architect/Engineers (if applicable) and the College's Operations & Engineering representatives.
- C. Commissioning Review: The project Commissioning Agent's final report detailing their findings, recommendations, and summary of any open issues shall be made available and reviewed in the course of the Project Turnover Meeting(s).

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MARK-UP SET OF CONTRACT DOCUMENTS

- A. During construction, Contractor shall maintain one set of contract documents at the site, dedicated for use as a Mark-Up Set of Contract Documents. The Mark-Up Set is separate from documents used for construction and shall include:
 - a. Drawings and Specifications, including any bid addenda
 - b. Specifications.

- c. RFIs, ASIs and Sketches
 - d. Change Orders and other modifications to the Contract.
 - e. Reviewed Shop Drawings, Product Data, and Samples.
 - f. Manufacturer's instructions for assembly and installation.
- B. Contractor shall record actual revisions of the Work for all trades, marking up plans and specifications as construction progresses and maintain continuously during the project.
- C. The plans shall be marked to show deviations in actual construction from the contract drawings. Deviations shall be shown in the same general detail utilized in the contract drawings. The drawings shall show the following information, but not be limited to:
- a. Locations and descriptions of any utilities constructed or located within the construction limits. Provide survey point numbers on the plans for reference.
 - b. Locations and dimensions of changes within the facility. Floor plan/layout changes should also include revised room numbers, as physically tagged in the field.
 - c. Changes in grade, alignment, location, elevations, details, and dimensions of all work including facilities, structures, roads and utilities.
 - d. Incorporate approved sketch (SK) drawings.
 - e. Where the contract drawings show options, show only the option used in construction.
- D. Record information concurrent with the construction progress, not less than weekly.
- E. Failure to maintain accurate as-built mark-ups will constitute sufficient justification for withholding payments to the Contractor.
- F. Maintain the Mark-Up Set (site "red-lines") so that it may be available for review by the Architect, College, and the College's representatives.
- G. The corrections on the Mark-Up set shall be incorporated into original contract plan CAD files for final delivery to the College as part of Project Record Documents, below. All plans shall be included in the set.

3.2 ADMINISTRATIVE CLOSEOUT

- A. Prepare and submit electronically and one (1) hard copy the following documentation to the User Agency. Each of the sections of Administrative Closeout shall be individual .pdf files emailed to the User Agency's Representative, copied to the Design Agent. All submissions shall be accompanied by a Transmittal Form indicating the date of the transmission and items included in the package.
- a. Certification of Work: Submit a written certification that the Contract Documents have been reviewed, the Work has been inspected, and that the Work is complete in accordance with the Contract Documents and is ready for the User Agency's review.
 - b. Asbestos Abatement Compliance: Provide submittals to Design Agent that are required by governing or other authorities, including abatement documentation, including but not limited to waste manifests, air clearance testing reports and other documentation correctly prepared as proscribed in the abatement plan. Failure to include correctly prepared abatement documentation will delay issuing of final payment.
 - c. AIA Document G706 - Contractor's Affidavit of Payment of Debts and Claims
 - d. AIA Document G706A - Contractor's Affidavit of Release of Liens
 - e. AIA Document G707 - Consent of Surety to Final payment

3.3 OWNER'S MANUAL

- A. Content of Owner's Manual:

- a. Title Page
 - b. Table of Contents
 - c. Project Overview
 - d. Project Team Contact List
 - e. Summary Equipment List
 - f. Operations and Maintenance Documentation, Organized by Specification Section
 - g. Materials and Finishes Schedule
 - h. Roofing and Building Envelope
 - i. Spare Parts and Maintenance Products Turnover Documentation
- B. Preparation of Owner's Manual: Project Overview.
- a. Provide Summary of the scope of work of the project.
 - b. Schedule summary including start date, completion date, and start and end date of the project Guarantee.
- C. Preparation of Owner's Manual: Project Team Contact List
- a. Directory, listing the names, addresses, and telephone numbers of the Design Agent, its Consultants, Contractor, Subcontractors, and major equipment suppliers.
 - b. Specifically list out Emergency contact list with contact names and twenty-four (24) hours contact information for use during the guarantee/maintenance period.
- D. Preparation of Owner's Manual: Summary Equipment List
- a. The Contractor shall compile a Summary Equipment List for all new equipment provided under the project. For renovation projects, include a separate spreadsheet for all equipment removed under the project
 - b. Contractor shall utilize the Owner's Standard Building Equipment Data Sheet template, providing information including but not limited to: make, model name, model number, serial number, location and area served. Include the name of subcontractors and suppliers, including local source of supplies and replacement parts. Ensure that all subcontractors, suppliers and replacement part providers are included in the Project Team Contact List.
 - c. Summary Equipment List shall be provided in both .pdf and editable Microsoft Excel.
- E. Preparation of Owner's Manual: The Operations and Maintenance Documentation. Contractor shall assemble a complete set of Operations and Maintenance (O&M) manuals indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. The Operations and Maintenance Documentation shall be organized by specification section and divided by each product or system. Provide the following information as applicable, separated with subdivides within each :
- a. Product cover page: System Name; Brand; Warranty Summary & Contact; Specification section; Description of purpose and area served; Names, addresses, and telephone numbers of the Subcontractors and suppliers.
 - b. Significant design criteria.
 - c. Each Item of Equipment and Each System: Include a description of the unit or system, size capacity, pressure drops, horsepower and the component parts. Identify the function, normal operating characteristics, and limiting conditions. As applicable, include performance curves, with priming data and tests, and complete nomenclature and model number of replaceable parts.

- d. Final approved shop drawings, submittal and cut sheet data detailing equipment performance data and features. For shop drawings: Provide with reinforced punched binder tab. Bind in with the text; fold the larger drawings to the size of the text pages.
- e. For each component, include the original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- f. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.
- g. Routine and Preventative Maintenance Requirements: Include the manufacturer's printed operation and maintenance instructions. Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions. Include a servicing and lubricating schedule, and a list of lubricants required. Include a list of the original manufacturer's spare parts, Predicted life of parts subject to wear current prices, and recommended quantities to be maintained in storage.
- h. Maintenance instructions for [special] finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
- i. Originals of product warranties and bonds.
- j. Other information as specified in the individual product specification Sections.
- k. Building Products, Applied Materials, and Finishes: Include product data, with the catalog number, size, composition, and the color and texture designations. Include information for re-ordering custom manufactured products.
- l. Instruction for Care and Maintenance: include manufacturer's instructions for cleaning agents and methods, precautions against detrimental agents and methods, and a recommended schedule for cleaning and maintenance.
- m. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.
- n. Charts of valve tag numbers, with the location and function of each valve.
- o. Equipment performance field test results, including HVAC system Test and Balancing (TAB) Report, motor alignment tests, etc.
- p. Electrical short circuit studies, circuit protective device coordination studies and arc flash studies
- q. Electrical panelboard and switchboard schedules
- r. As installed schedules for lighting fixtures, lamps, and ballasts
- s. Other data as required under pertinent sections of specifications
- t. Provide and install framed charts in appropriate building MEP rooms for One Line diagrams, process flow diagrams and valve charts.
- u. Software: Provide copies of system software and device configuration files for all electronic systems installed under the project. Files to be provided on formatted CD, mass storage device or other acceptable media. Include applicable software documentation and User Manuals. Systems requiring software backup include but are not limited to:
 - a. Building Automation Systems (BAS)
 - b. Fire Alarm Systems and Smoke Control Systems
 - c. Elevator Controls
 - d. Lighting Controls

- v. Door Access Control Systems
- w. Additional information required for Electrical, Controls and HVAC Sections:
 - a. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
 - b. Include sequence of operation by the controls manufacturer.
 - c. Include color-coded wiring diagrams and process flow diagrams as installed for applicable systems: One Line and Process Flow diagrams (11x17) for applicable systems: Mechanical (heating, cooling, piping, process water and specialty systems), HVAC (Air handlers, ductwork, piping), Plumbing, Electrical (normal, standby power systems and specialty systems), Fire Alarm and Security and Telecom
 - d. Include control diagrams by the controls manufacturer as installed.
 - e. Include the Contractor's coordination drawings, with color-coded piping diagrams as installed.
 - f. Include charts of valve tag numbers, with the location and function of each valve, keyed to the flow and control diagrams.
 - g. Include test and balancing reports as specified in Section 01 40 00.
 - h. Boiler and elevator and other applicable certificates and operating permits/licenses, DEM permits including generator permits
 - i. Test and inspection documentation including fire pump test data, asbestos abatement plans and manifests.
- F. Materials and Finishes Schedule shall be submitted in conjunction with O&M manual general requirements. Materials and Finishes manual is for architectural products, applied materials and finishes.
 - a. Final As-Built surfaces finish schedule, keyed to reduced size floor plans.
 - b. Additional Requirements: As specified in the individual product specification Sections.
- G. Spare Parts and Maintenance Products Turnover Documentation: provide signed transmittals indicating materials delivered, date, location, name, title and signature of person who received the items.
- H. Formatting
 - 1. Submit the Owner's Manual bound in 8-1/2 x 11 inch text pages, in minimum 2 inch size three D side ring commercial quality binders with durable cleanable plastic covers. Pages shall be duplex printed.
 - a. Prepare binder covers with the typed title of the manual, title of the project, and the subject matter of binder. Label each spine with the following: Building, project or facility name, project number, submission date.
 - b. Internally subdivide the binder contents with typed permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs. Tabs shall match the headings provided in 3.3.A, Content of Owner's Manual, above.
 - c. The Electronic format shall be organized by Construction Specification Institute (CSI) divisions and include all materials/equipment/systems installed in the building. There shall be one pdf file created for each CSI division.
 - d. Electronic .pdf shall be "OCR" keyword searchable, bookmarked by section. File and folder names shall be as mutually agreed.
- I. Draft Submission

- a. Submit electronically a preliminary draft of the Owner's Manual thirty (30) calendar days prior to the contractual Substantial Completion date. The Design Agent and its consultants will review drafts and return electronically with comments. Contractor shall make revisions as noted.
 - b. A resubmitted draft shall be provided electronically and as one (1) hard copy at contractual Final Completion. This copy will be reviewed and returned after final inspection, with the Design Agent's comments. Revise the content of the document sets as required prior to final submission.
- J. Final Submission: Submit three (3) sets of revised final volumes plus electronic copy in final format within ten (10) days after receipt of final comments.

3.4 PROJECT RECORD DOCUMENTS

- A. Project Record Documents shall comprise of the following:
 - a. As-Built Drawings.
 - b. Record Specifications.
 - c. Record Contract.
- B. Preparation of As-Built Drawings
 - a. At the end of construction, the Design Agent will provide to the Contractor a complete set of CAD file(s) with all the plan adjustments (bid addenda, bulletins and sketches produced by the Design Agent) fully incorporated into the base CAD file(s). This shall happen within 14 days of Substantial Completion.
 - b. The Contractor shall retain Competent Drafting Personnel and will coordinate the process to take all field changes/adjustments by all Subcontractors. The Competent Drafting Personnel shall transfer this information and the Mark-Up Set accurately to the CAD file(s). All hand-drawn SK's that are not included in the Design Team's electronic update must be added to the CAD file(s) by the Contractor.
 - c. The Contractor shall also include any electronic "MEP coordination drawings" produced by the construction team in the final electronic As-Builts. The coordination drawings shall not replace any of the original contract drawings, and they shall be fully labeled both to demonstrate the area of the building shown and to identify all elements shown on the plan. If abbreviations are used, a key must be included on these plans.
 - d. Include site surveys and As Built. Measured horizontal and vertical locations of the underground utilities and appurtenances, referenced to permanent surface improvements. Include the locations and description of any existing utility lines and other existing installations of any kind or description encountered during construction. Note all changes in size, material, location, and elevation of all new or abandoned underground utility lines and pertinent work, including site grading. Document topography and drainage changes. Show the location of all valves, manholes, etc. and include dimensions to permanent features such as building corners. Note direction of each new valve opening. Show clearances between new utilities and existing crossed lines. Locate all bends, thrust blocks, and other restraints.
 - e. The placement, size, and type of any fire extinguishers.
 - f. Measured locations of internal utilities and appurtenances concealed in the construction.
 - g. Details not on the original Contract drawings, including field changes of dimension and detail.
 - h. Provide low voltage cabling plans, including showing all splices.
 - i. The Contractor will ensure that all notes and schedules included in the design drawings are updated to accurately reflect actual installed conditions.
 - j. The As-Built Drawings shall include a cover page and content index.

- k. As-built Drawings shall be labeled so that the following information is legible when rolled as well as on a cover page: Building, project or facility name, Design Agent's project number, and submission date.
- C. Preparation of Record Specifications: Include cover page, title page, table of contents and tabulated and divided by Specification Section. Prepare in binders and electronically as per 3.4.E, Format, below. For each Specification, prepare a summary and provide documentation as follows. Each page shall include the Specification Section Number and Title.
- a. Part 1 – General: Statement of compliance with General subsection or description of any deviations
 - b. Part 2 – Products: For each installed item covered in the Specification Section, provide a copy of the Product Cover Page (from the Owner's Manual).
 - c. Part 3 – Execution: Statement of compliance with Execution subsection or description of any deviations. Include any ASI or RFI responses in support of actual installation.
- D. Preparation of Record Contract: Include cover page, title page, table of contents and tabulated and divided. This list is not all inclusive; final list shall be agreed upon with Design Agent and User Agency, based on review of the draft.
- a. State Purchase Order
 - b. Bid Form
 - c. Executed AIA A101 and A201
 - d. State Change Orders, including Purchase Order, AIA Cover Sheet and Backup. Provide a tab for each Change Order.
 - e. Correspondence and Project Meeting Minutes.
 - f. Copies of Contractor's project warranty letter, Subcontractor warranty letters and special guarantees and warranties such as roofing, waterproofing, windows and doors as applicable.
 - g. Project Documents and Certificates (trade permits and 128 Forms, Final Certificate of Occupancy, etc.).
 - h. Certificate of Substantial Completion
 - i. Original and Updated Project Schedules
 - j. Project Progress Photographs
 - k. Additional Associated Materials. Each shall be considered a separate section, identified in the table of contents and divided as such. Example items include but not limited to:
 - a. National Grid Rebate Applications.
 - b. LEED scorecards
 - c. If the project required geotechnical, archeological, or other miscellaneous studies or other reports, these shall also be submitted as Record Documents.
- E. Project Record Documents Format: Printed
- a. As Built Drawings shall be organized into 3 sets, stapled with edge binding. The title block, visible when drawings are rolled, shall state the building name, title of the project, substantial completion date, Design Agent and Contractor.
2. Record Specifications and Record Contract Documents shall be printed duplex on 8-1/2 x 11 inch text pages, in minimum 2 inch size three D side ring commercial quality binders with durable cleanable plastic covers.
- a. Prepare binder covers and spline labels with the printed title of "Project Record Documents", building name, title of the project, substantial completion date, Design Agent and Contractor, and the subject matter of binder.

- b. Provide cover pages and internally subdivide the binder contents with permanent page dividers, based on the following sections, as applicable.
- F. Project Record Documents Format: Electronic
 - a. All .pdf shall include bookmarks for Sections and be “OCR” keyword searchable.
 - b. Folder structures and file names shall be as agreed.
- G. Project Record Document Draft
 - a. Contractor shall prepare an electronic draft of the project record documents for review by the Design Agent and the User Agency fifteen (15) days prior to final inspection, or within twenty-one (21) days of receipt of updated electronic files from the Design Team, whichever comes first.
 - b. Ensure the entries are complete and accurate, enabling future reference by the User Agency.
 - c. All Design Agent and User Agency comments/mark-ups on the draft package shall be returned to the Contractor within twenty-one (21) calendar days. The Contractor shall make corrections as noted and resubmit within twenty-one (21) calendar days.
- H. Final Submission
 - a. Within fifteen (15) calendar days of receiving final approval of the corrected drafts, the Contractor shall submit three (3) printed, bound copies and one (1) electronic copy of all documents.

3.5 FINAL APPLICATION FOR PAYMENT

- A. Refer to AIA A101-2017 §5.2. Following the requirements of Section 01 20 00, submit the final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due to the Design Agent.
- B. Design Agent shall work with the User Agency to determine that all requirements have been fulfilled, and if so, issue a final Certificate for Payment.

END OF SECTION

SECTION 01 78 13 – COMPREHENSIVE LIST OF INCOMPLETE ITEMS**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Contractor's comprehensive list of incomplete Items
- B. Related Requirements:
 - 1. Section 01 78 00 – Closeout Procedures for requirements for Architect's Inspection for Substantial Completion.

1.3 DEFINITIONS

- A. Comprehensive List of Incomplete Items: A listing of the Work prepared by the Contractor that identifies outstanding items to be completed or corrected prior to final payment. This term is further defined in §9.8.2 of AIA® Document A201™ - 2017, General Conditions of the Contract for Construction. The list is for the Architect's reference in advance of the Architect's Inspection for Substantial Completion.
- B. Punch List: An incorrect term for "Comprehensive List of Incomplete Items."

1.4 SUBMITTALS

- A. Informational Submittals
 - 1. Contractor's Comprehensive List of Incomplete Items
- B. Action Submittals
 - 1. None

1.5 CONTRACTOR'S COMPREHENSIVE LIST OF INCOMPLETE ITEMS

- A. Content of list:
 - 1. Include the following at the beginning of the list:
 - a. Contractor's certification, identifying name(s) of personnel that prepared the list.
 - b. Contractor's signature.
 - 2. Prepare and submit a detailed, legible description of the outstanding Work to be completed or corrected.
 - 3. Include the following with each item:
 - a. Room number and name.
 - b. Room specific Item number for each listed item.
 - c. Photograph(s) if necessary.
 - d. The value of each item on the list.

- e. The reason(s) why the Work is incomplete.
 - f. Name of Contractor, and subcontractor(s) to perform Work.
 - g. Date for when Work will be completed or corrected.
 - h. Identify any additional area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
- B. Organization of List:
1. At a minimum, each space shall be on its own page. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
 2. Organize list of spaces in sequential order, starting with exterior areas first, and proceeding from lowest floor to highest floor, listed by room or space number.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Project number.
 - c. Date.
 - d. Name of Architect.
 - e. Name of Contractor.
 - f. Page number.
- C. Format of List: Submit the list in the following format:
1. PDF Electronic File
 2. Web-Based Project Software Upload: At Contractor's option, utilize software feature for creating and updating list of incomplete items.
 3. One (1) Paper Copy directly to Owner, if requested.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONTRACTOR'S INITIAL LIST

- A. When the Contractor considers that the Work is substantially complete, the Contractor shall prepare and submit the initial list.

3.2 UPDATED LISTS

- A. The Contractor shall prepare and submit an updated list (14) fourteen calendar days after submitting the initial list, and every (14) fourteen days thereafter until final acceptance/payment by Owner.
- B. Updated lists shall include any missing items identified since the previous list was submitted, to include those identified by the Owner, Architect, Engineer(s), Commissioning Agent and/or AHJ.

END OF SECTION 01 78 13

SECTION 02 41 00 DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. General: The work described in this Section consists of selective demolition, cleaning, removal and legal disposal of all structures, equipment and materials indicated for demolition, or careful removal and temporary storage of materials and equipment indicated for salvage and re-use, or salvage and delivery to Owner. No attempt is made in this Section to list the entire scope of selective demolition required on this project or to describe each element to be removed. Drawings indicate both existing construction and final construction. It is the responsibility of the Contractor to determine for itself the scope and nature of the existing materials, equipment and finishes required for removal or salvage, based on the information provided in the full set of Contract Documents.
1. Comply with requirements of Division 01 – GENERAL REQUIREMENTS.
- B. Permits: Obtain and pay for all demolition and construction permits required by local authorities having jurisdiction and other regulatory agencies and utility companies.
- C. Selective demolition and removal work includes the following at indicated locations, but is not limited to:
1. Cut existing concrete slabs and trench beneath slabs-on-grade to install conduits for new floor outlets. Remove concrete slabs in the general areas indicated. Minimize extent of the sawcuts to suit the required width for the individual trenches.
 2. Remove existing lights, diffusers, grilles, speakers and similar equipment where scheduled to be replaced.
 3. Provide selective demolition on Level 2 and slab penetrations to install the new mechanical piping that connects to the new roof mechanical roof equipment.
 4. Remove wood storage shelving, cabinetry, casework and similar items
 5. Remove designated interior partitions, ceiling and suspension systems, and flooring systems
 6. Remove designated building specialties.
 7. Remove all furnishings, utilities, equipment and fixtures, not indicated for salvage or re-use, and abandoned materials of all kinds.
 8. Remove from site all abandoned, disconnected and dismantled fire protection, plumbing and mechanical equipment, including piping, conduits, system wiring, meters and other devices.
 9. Remove from site all abandoned, disconnected and dismantled electrical fixtures and equipment, including conduits, wiring, meters and other devices.
 10. In addition to demolition specifically shown, cut, move or remove existing

construction to remain as necessary to provide access or to allow alterations and new work to proceed. Coordinate such relocation's and removal to accommodate the demands and requirements of other trades.

- D. Selective demolition and removal work by individual utility, mechanical and electrical trade subcontractors includes, but is not limited to the following:
1. Each trade subcontractor shall Disconnect cut, cap and make safe all utilities, equipment and fixtures which are not indicated for salvage or re-use, or otherwise indicated to be abandoned in place as well as any abandoned materials of any kind.
 - a. Disconnect cut, cap and make safe, all utility services indicated to be demolished at their primary source. Obtain the approval from authorities having jurisdiction, or applicable service provider prior to the execution of the work.
 - b. Cut, cap and make safe all existing utility services indicated to be abandoned in place, where so indicated on the Drawings.
 2. The fire suppression subcontractor shall disconnect, detach and dismantle all existing abandoned sprinkler/fire suppression components including, but not limited to, sprinkler heads, piping, hangers, valves, and appurtenances.
 - a. Suspended hangers, piping, fixtures and appurtenances scheduled for demolition, shall be disconnected and lowered to floor by the fire suppression subcontractor.
 3. The plumbing subcontractor shall disconnect, detach and dismantle all existing abandoned plumbing systems and equipment including, but not limited to, fixtures, equipment, water heaters, piping, hangers, valves, insulation and appurtenances.
 - a. Piping at slab will be disconnected by plumbing subcontractor.
 - b. Suspended hangers, piping, equipment, fixtures and appurtenances scheduled for demolition, shall be disconnected and lowered to floor by the plumbing subcontractor.
 4. The HVAC subcontractor shall disconnect, detach, dismantle all existing abandoned heating, ventilating, and air conditioning systems including, but not limited to, air handlers, air conditioners, pumps, cabinet unit heaters, unit heaters, radiation, exhaust fans, intakes, louvers, diffusers, grilles, and all related piping, ductwork, controls, and appurtenances.
 - a. Suspended hangers, equipment, ductwork and appurtenances scheduled for demolition, shall be disconnected and lowered to floor by HVAC subcontractor.
 5. The Electrical subcontractor shall disconnect, detach, dismantle all existing abandoned electrical systems and equipment including, but not limited to, panelboards, light fixtures, fire alarm, intercom, speakers, wiring devices, and all related conduit and appurtenances.
 - a. Suspended wiring, conduit, hangers, fixtures, equipment, and appurtenances scheduled for demolition, shall be disconnected and

lowered to floor by the Electrical subcontractor.

6. Remove, salvage and furnish to the General Contractor designated equipment, fixtures or other items so identified. Refer to notes on Drawings.
 7. Identify locations of utilities for work of other sections.
- E. Remove, salvage, and furnish to Owner for maintenance stock, or other future use, the following products. Carefully package and clearly identify prior to delivery to Owner.
1. As indicated on Drawings.
- F. Conduct walk-through of existing site prior to commencement of selective demolition work and jointly identify and tag with Owner items required to be salvaged. These products in general would be in addition to those indicated on Drawings.
1. All salvaged products not designated for re-use in project, shall be furnished to the Owner for its own use, carefully packaged and clearly identified.
- G. Identify locations of utilities for work of other sections.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 01 81 13 - SUSTAINABLE DESIGN REQUIREMENTS: Special administrative and procedural requirements related to LEED VERSION 4 FOR BUILDING DESIGN AND CONSTRUCTION" (LEED V4 BD+C) "Gold" certification based on USGBC's LEED v4 BD+C. Certificate goals of energy conservation and efficiency, indoor air quality, and natural resource efficiency.
- D. Section 03 01 30 – REHABILITATION OF CONCRETE
1. Concrete repair, infill, and topping of existing concrete subflooring and finish flooring system substrate.
 2. Fill and level with concrete all depressions left in floor surfaces after alteration work has been completed.
 3. Grind floors to remove all high spots.
- E. Division 21 - FIRE SUPPRESSION
1. Disconnection, salvage, re-working and re-installation of sprinkler system.
 2. Disconnection and dismantling designated fire suppression systems and components.
- F. Division 23 - HEATING, VENTILATING AND AIRCONDITIONING (HVAC):
1. Disconnection, salvage, re-working and re-installation of roof-top ventilator

ducts.

2. Disconnection and dismantling designated mechanical systems and components.
- G. Division 26 - ELECTRICAL:
1. Disconnection and dismantling designated electrical systems and components.
 2. Disconnection, salvage, and re-installation of designated light fixtures.
- H. Division 31 - EARTHWORK: Excavation and backfilling for foundations, ramps, below-grade utilities, retaining walls, and exterior concrete slabs.
- I. Individual specification sections: Cutting and patching incidental to work of individual specification sections shall be performed by respective trades, except as specified in Division 01 – GENERAL REQUIREMENTS.
- J. Individual specification sections: Utility shutoffs by respective trades.

1.3 REFERENCES

- A. Reference Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
1. ANSI A10.6 – Safety Requirements for Demolition Operations.
 2. NFPA 241 – Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.4 OWNERSHIP OF REMOVED MATERIALS

- A. If during the work, articles of unusual value, or of historical or archaeological significance, are encountered the ownership of such articles is retained by the Owner, and information regarding their discovery shall be immediately furnished to the Architect. Resolution shall be handled as a Change in the Work.
- B. Ownership of materials, equipment and furnishings designated for salvage for re-use in this Project or designated for Owner's use is retained by the Owner.
- C. Ownership of materials, equipment and furnishings to be removed from the Project which are not defined by the above two paragraphs is retained by the Contractor; if any of these are considered of salvageable value to the Contractor, they may be removed from the Project as work progresses.
1. On-site storage or sale of removed items is prohibited.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Comply with all requirements of this contract relative to protection, scheduling and coordination with the Owner.
 2. Hazardous materials: When hazardous materials are encountered, they shall be handled, removed, and disposed of in accordance with all regulatory agency requirements.
 3. Coordinate and arrange with utility, mechanical and electrical trades for their disconnecting, rerouting and maintenance of existing services leading to adjacent occupied buildings, as part of the work of this Contract.
 4. Coordinate Work of this Section with related utilities work identified in the Contract Documents.
- B. Pre-Demolition Meeting: At least two weeks prior to commencing the work of this Section, conduct a pre-demolition conference at the Project site. Comply with requirements of Division 01 – GENERAL REQUIREMENTS. Coordinate time of meeting to occur prior to installation of work under the related sections named below.
1. Required attendees: Architect, Contractor's project manager and on-site superintendent, demolition subcontractor's project superintendent, and representatives of related utility trades.
 2. Conference Agenda:
 - a. Scheduling of demolition operations. Review critical demolition sequencing with other work.
 - 1) Coordination scheduling with Owner's ongoing operations.
 - b. Coordination of utility service requirements and disconnects.
 - 1) Review functioning utility services which are to remain in service throughout demolition work.
 - 2) Review requirements for marking location of disconnected utilities, and project record (as-built) requirements.
 - c. Review conditions of existing construction to be demolished.
 - 1) Review extent and location of selective demolition.
 - 2) Review special demolition and salvage procedures required for historic building elements.
 - 3) Exploratory demolition and concealed conditions.
 - d. Coordination of demolition work with work of other contracts.
 - e. Review shoring and bracing procedures, and structural load limitations of existing structure.
 - f. Review of site use, staging, and storage locations for salvaged materials and materials for recycling program.
 - g. Review extent and location of selective demolition. Review areas where existing construction is to remain and requires protection
 - h. Review special requirements for temporary protection of existing finishes and materials to remain.
 - i. Review requirements of work performed by other trades that rely on substrates exposed by demolition operations.

- j. Procedures for processing field decisions.
 - k. Procedures for handling hazardous materials.
 - l. Review fire protection procedures for cutting torches, and other potentially hazardous operations.
 - m. Review general safety regulations and requirements for demolition work.
- C. Sequencing:
- 1. Coordinate and arrange with mechanical and electrical trades for their disconnecting, rerouting and maintenance of existing services in the buildings as required, as part of the work of this Contract.
- D. Scheduling:
- 1. Comply with all requirements of this contract relative to protection, scheduling, phasing, and coordination with the Owner.
- 1.6 SUBMITTALS
- A. Information and Review Submittals: Submit the following under provisions of Section Division 01 – GENERAL REQUIREMENTS:
- 1. Schedule: Prior to commencement of work, prepare a schedule indicating proposed methods and sequence of operations for demolition work.
 - a. Include coordination for shut-off, capping, and continuation of utility services as required, together with details for dust and noise control protection.
 - b. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations. Receive acceptance from Architect prior to commencing work.
 - 2. Shop drawings: Indicate demolition sequencing and locations of salvageable items.
 - 3. Design Data: Submit calculations for bracing and shoring, signed and sealed by professional engineer registered in the State of Rhode Island.
 - 4. Permits: Submit copy of permits required by regulatory agencies for demolition.
 - 5. Special Procedure Submittals: Submit copies of written agreements from private landowners, landfill operators, or other agencies accepting disposal of demolished materials at least two weeks prior to commencement of demolition work.
- B. Closeout Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS.
- 1.7 REGULATORY REQUIREMENTS
- A. Conform to applicable codes for demolition work, safety of structure, dust control, and disposal of debris. Conform to procedures applicable when discovering hazardous materials or contaminated substances.

1. The Contractor is directed not to disturb or attempt removal of any discovered hazardous materials or contaminated substances. Immediately notify both the Owner and the Architect upon discovery of such conditions.
- B. Obtain and pay for required permits and licenses required from authorities prior to commencing demolition work. Arrange and pay for legal disposal of removed materials and equipment, obtain proper disposal receipts for verification.
- C. Notify affected utility companies and Owner before starting work and comply with utility company requirements.
- D. Do not close or obstruct egress width to exits. Do not disable or disrupt building fire or life safety systems without 3 days prior written notification to the Owner.

1.8 QUALITY ASSURANCE

- A. General: Conduct the work in a manner giving prime consideration to protection of the public; protection from the weather, control of noise, shocks and vibration; control of dirt and dust; orderly access for and storage of materials; protection of existing buildings; protection of adjacent surfaces and property; coordination and cooperation with the Owner at all times.
 1. Comply with all requirements of this contract relative to protection, scheduling and coordination with the Owner.
- B. Qualifications:
 1. Demolition subcontractor: Company specializing in performing work of this section with minimum 3 years documented experience.
 2. Shoring and bracing design: Design shoring, and bracing, under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.9 SITE CONDITIONS

- A. Comply with wind and weather conditions established at pre-demolition meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Condition of Structures: Owner assumes no responsibility nor makes any claim as to the actual condition or structural adequacy of any existing construction to be demolished. The Contractor shall investigate and assure himself of the condition of the work to be demolished and shall take all precautions to ensure safety of persons and property.
 1. Notify both Owner and Architect, if any type of hazardous chemicals, gases, explosives, flammable material, unmarked containers, or similar dangerous

substances are discovered. Cease work in affected areas until directed by Architect. Continue work in other areas.

- B. The Contractor shall have examined the existing conditions per requirements of the Conditions of the Contract and Division 1 - General Requirements, and reviewed Contract Documents prior to commencement of demolition. Coordinate and verify scope of selective demolition with other portions of work specified in other sections, and under separate Contract. Change orders will not be issued for the removal of any exposed to view materials or equipment, which are either indicated on the Drawings for removal, or not indicated, but necessary to remove for the Work of this Project.
- C. Prior to commencement of selective demolition work, inspect areas in which work will be performed. Photograph existing damage to structure surfaces, equipment, or to surrounding properties which could be misconstrued as damage resulting from selective demolition work; file with Architect prior to starting work. Comply with requirements of Division 01 – GENERAL REQUIREMENTS.

3.2 PREPARATION

- A. General: Provide necessary protection of non-work areas during demolition operations. Provide, erect and maintain temporary barriers as required to protect non-construction related pedestrian and vehicular traffic using the adjacent portions of the site and building.
 - 1. Erect and maintain temporary partitions to prevent spread of dust, odors, and noise to permit continued Owner occupancy of adjacent facility.
- B. Protect existing structures which are not to be demolished. Protect designated materials and equipment to be removed and retained by Owner.
 - 1. Cover or otherwise protect as necessary existing equipment, furniture and furnishing located beyond the immediate demolition work.
 - 2. Protect existing landscaping materials, structures, and appurtenances which are not to be demolished.
- C. Prevent movement of structure; provide required bracing and shoring.
 - 1. Protect existing active utility services and structures from damage during selective demolition work including during installation of bracing and removal of same. Repair or replace damages to satisfaction of Owner.
- D. Dangerous Materials: Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with demolition operations.

3.3 GENERAL REQUIREMENTS FOR SELECTIVE DEMOLITION

- A. Conduct demolition to minimize interference with adjacent building areas, in compliance with governing laws and buildings, with prime consideration given to the

safety, protection and convenience of the public and Owner's personnel.

1. Maintain protected egress and access to the Work at all times.
- B. Perform selective demolition in an orderly and careful manner. Carefully cut materials to be removed to eliminate damage to portions to remain. Protect existing structure designated to remain.
1. Do not demolish building elements beyond what is indicated on Drawings without Architect's approval.
 2. Except as otherwise required by Project phasing requirements, proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 3. Locate equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 4. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent. Do not throw trash from windows or from roof.
 5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 6. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 7. Pull nails and fasteners which remain after removal of attached material. Remove lath, strapping and other substructures associated with finishes to be removed.
 8. Where existing finishes are indicated to be removed, remove down to bare subsurface without causing damage to the subsurface.
 - a. After removal of non-asbestos finish flooring materials, remove underlying mastic and prepare substrate to receive new flooring materials by Shot Blasting method. Create a uniform 20 mil profile. Mechanically scarify areas which cannot be profiled by shot blast method. Thoroughly wash all flooring substrate and leave clean and dry ready for application of new flooring materials.
- C. Cutting openings and holes: Neatly cut openings and holes plumb, square, and true to dimensions required. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces.
1. All penetrations in floors and roof shall be framed with miscellaneous metal work prior to cutting and demolition of deck and concrete.
 2. Repair damage done to existing elements of building to remain, except repairs specified to be provided under other Sections. Repairs shall be done in such manner as to closely match construction, appearance and quality of original work.
- D. Use of cutting torches:

1. Do not use cutting torches until work area is cleared of flammable materials.
 2. Maintain adequate ventilation when using cutting torches.
 3. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations.
- E. Maintain fire watch and portable fire-suppression devices during flame-cutting operations. Comply with fire prevention measures specified under Section Division 01 – GENERAL REQUIREMENTS. Carefully observe existing structure during demolition operations, cease operations immediately if structure appears to be in danger. Immediately notify both Architect and Owner's Project Representative. Do not resume demolition operations until directed.
- F. Disconnect, cap and clearly identify designated utilities within demolition areas.
1. Cap and remove abandoned existing utilities back to locations indicated, or to limit line of Contract where terminations are not indicated.
 - a. Pipes to be demolished that require a connection shall be removed to the extent required to install the new connection. Remove pipe sections by saw-cutting, removing a complete pipe section to an existing joint, or other adequate means which results in a clean joint.
 2. Protect and maintain conduits, drains, sewers, pipes, and similar utilities that are not to be demolished
- G. Disconnect existing equipment and fixtures to be removed, or services abandoned, and piping, wiring, and conduit which would otherwise be exposed in the finished work. Remove from site disconnected equipment and fixtures and piping not to be reused.
1. Contractor to remove and dispose of all equipment not tagged or scheduled for reuse.
- H. Abandoned Equipment, Utilities, Systems: Remove in their entirety. Abandonment in place is not acceptable, except where an item is specifically indicated to be abandoned in place.
1. "Abandoned" means the item is not operational in the completed Contract.
 2. Without limitation, remove abandoned pipes, tubing, conduits, wires, cables, ducts, equipment, machines, and all elements and items related to abandoned work including, without limitation, hangers, connectors, anchors, valves, drains, strainers, sumps, panels, mounting boards, grounding rods, ground connectors, boxes, dampers, plenums, insulation, escutcheons, trims, and all other related items.
 3. Where an existing element is indicated to be abandoned in place, the abandoned item shall be cut off and, if hollow, capped.
 - a. Cut off sufficiently below the finished plane to permit space for patching over the abandoned element. The General Contractor shall provide all cutting and chipping required to recess the cut element, and to coordinate depth of cut-offs required for finishing.

3.4 BRACING

- A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move a brace, install new bracing prior to removal of original brace. Provide suitable bracing materials which will support loads imposed
- B. Do not place bracing where it will be cast into or included in permanent concrete work, except as otherwise acceptable to Architect.
- C. Install internal bracing, if required, to prevent spreading or distortion to braced frames.
- D. Maintain bracing until structural elements are rebraced by other bracing or until permanent construction is able to withstand designed live and dead loads.
- E. Remove bracing in stages to avoid disturbance or damage to existing structure.
- F. Repair or replace adjacent work damaged or displaced through installation or removal of bracing work.

3.5 EXPLORATORY DEMOLITION AND CONCEALED CONDITIONS

- A. Exploratory Demolition and Concealed Conditions:
 - 1. Selective demolition work includes controlled exploratory demolition work which is indicated on Drawings and as may be additionally field directed by the Architect. Additional exploratory demolition may also be required to thoroughly investigate and determine the exact location of existing concealed work or to expose concealed conditions to view.
 - 2. Exploratory demolition may be used to clarify the Contract Documents to improve the interface of new and existing work.
- B. Concealed conditions: Carefully check for concealed structure, pipes, conduits, wires, utilities, systems, and other elements before beginning cutting and selective demolition work.
- C. Discovery: When unknown, concealed utilities and systems are discovered, verify the purpose, routing, circulation, origin, and termination of these items.
 - 1. If the unknown, concealed items are part of a system to be abandoned, remove the item in its entirety.
 - 2. Protect discovered concealed items are part of an existing system to be preserved and incorporated into the Work, or part of an active system to remain. Protect system elements from disturbance and notify both Owner and Architect and follow the Architect's directions
 - a. In circumstances when existing system to remain is damaged due to the Work (including cutting, demolition or exploratory investigation) notify both Owner and Architect immediately. Repair or re-route the damaged system components as directed by the Architect at no additional cost to the Owner

3.6 GENERAL DUST CONTROL

- A. Contractor shall employ dust and pollution prevention procedures at all times. Compliance with requirements for dust protection and air quality control is required for work areas which abut Owner occupied areas. Dust removal and periodic cleaning requirements apply to all work. Contractor shall employ dust and pollution prevention procedures so that a healthy Owner's environment is fully maintained at all times. Compliance with the requirements in Division One for dust control is mandatory and may not be compromised at any point during construction.
1. Clean up loose debris daily, or more frequently as required, to prevent the wind spreading debris. Keep dumpsters covered when not in use.
 2. Cover handcarts carrying debris being transported through Owner occupied areas.
 3. Wet down debris (as appropriate) to prevent air pollution by dust rising from demolition work. Wet down dumpsters to prevent fires caused by vandals.
 4. Employ tarpaulins on all trucks carrying debris.

3.7 SALVAGE MATERIALS AND PRODUCTS

- A. Carefully salvage and provide safe storage for products designated for salvage, reuse, as indicated on the Drawings, as specified herein, or as requested by Owner for reuse on the project, or to be stored for Owner's future use. Take particular care with finished items and items requiring special handling.
1. Remove items indicated to be salvaged with extreme care to prevent damage.
 2. All components and parts of salvaged items shall be saved and packaged.
- B. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area as designated by Owner.
 5. Protect items from damage during transport and storage.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.8 SELECTIVE DEMOLITION REQUIREMENTS FOR MATERIALS AND SURFACES.

A. Floors, General:

1. Completely remove existing flooring located in areas scheduled to receive new flooring surfaces and as additionally indicated. Remove all finish flooring layers of flooring down to the existing substrate.
 - a. Completely remove flooring systems to substrate, including full removal of all setting beds and adhesives.
2. Remove resilient flooring and adhesive in strict accordance with the technical bulletin entitled " Recommended Work Practices for the Removal of Resilient Floor Covering", as issued by Resilient Floor Covering Institute (RFCI).
3. Patching: The Contractor is responsible for patching of flooring substrates and subfloors. Respective finish flooring trades are responsible for patching of finish flooring systems matching abutting surface.

B. Walls, General:

1. Remove interior walls and partitions as indicated and as needed to accommodate new work.
2. Where existing walls-to-remain are indicated to receive new finishes, completely remove trim and fasteners.
3. Patching: The Contractor is responsible for patching of substrates and back- up systems. Finishes work shall be provided under individual product specification sections.

C. Ceilings, General:

1. Patching: The Contractor shall provide patching of substrates and back-up systems. Ceiling work is specified under individual product specification sections.
 - a. Ceilings which must be temporarily removed for mechanical, plumbing or fire protection work shall be carefully removed and stored for reinstallation when work has been completed under Section 09 51 00 - Acoustical Ceilings.

D. Doors and Frames: Where doors and frames are indicated to be removed from walls or partitions which are to remain, remove doors and frames carefully so as to minimize damage to wall. Repair and patch wall as necessary to accommodate new door frame or other new work.

E. Fire Suppression and Sprinkler Equipment: Fire Protection subcontractor is responsible to disconnect, cap and lower to floor items required to be removed, including but not limited to piping, hangers, valves, and insulation.

F. Heating, Ventilation, Air Conditioning, and Refrigeration (HVAC&R) Equipment:

1. Drain system components designated for disposal of all lubricants, hydraulics, and refrigerants without releasing into atmosphere.

2. HVAC&R subcontractor(s) shall disconnect, cap and lower to floor items required to be removed, including but not limited to, ductwork, piping, fans, VAV boxes, unit ventilators, and all similar system equipment. Contractor is responsible for removal from site and proper disposal.

G. Electrical Equipment and Lighting Fixtures:

1. Electrical subcontractor(s) shall disconnect, cap and lower to floor items required to be removed, including but not limited to, panelboards, light fixtures, and overhead devices including, fire alarm, intercom, bus ducts. Contractor is responsible for removal from site.

3.9 REPAIRS

- A. Repair all damage done to elements of buildings and structures to remain, except repairs specified to be provided under other Sections, or as indicated for removal in subsequent project phase(s). Repairs shall be done in such manner as to closely match construction, appearance and quality of original work.

3.10 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated or specified to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
1. Comply with requirements Division 01 – GENERAL REQUIREMENTS, and specified waste diversion goals.
 2. As work progresses, regularly remove demolished materials from site. Do not allow demolished materials to accumulate on-site, except as required for materials determined to be reused, salvaged, or as required for waste segregation and diversion for recycling.
 3. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 4. Liquid Waste Management: Dispose of liquid waste in accordance with all applicable regulations. Consult all regulations (federal, provincial, state, local) or a qualified waste disposal firm when characterizing waste for disposal. Contact manufacturer for MSDS sheets for product information, and recommendations for proposal disposal. Utilize licensed waste disposal companies as may be required.
- B. Do not burn or bury demolished materials on site, arrange for legal disposal of the same.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.
1. Comply with waste management reporting requirements on forms acceptable to the Owner. Comply with requirements of Division 01 – GENERAL REQUIREMENTS.

2. Comply with waste management reporting requirements on forms acceptable to the Owner.
3. Record the amount (in tons or cubic yards) of material landfilled from the Project, the identity of the landfill, the total amount of tipping fees paid, transportation costs (if separate) and the total disposal cost. Include manifests, weight tickets, receipt, and invoices.

3.11 CLEANING

- A. Daily cleaning: Sweep all street and roads affected by demolition operations.
- B. Upon completion of the work of this Section; remove unused tools and equipment, surplus materials, rubbish, debris, and dust. Leave area in raked or broom-clean condition, as appropriate.
- C. Upon completion of the work of this Section; clean adjacent structures and facilities of dust, dirt and debris caused by demolition work to the satisfaction of Owner, owner(s) of adjacent properties, and authorities having jurisdiction.

End of Section 02 41 00

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SECTION 05 50 00 METAL FABRICATIONS**PART 1 - GENERAL**

1.1 SUMMARY

- A. The work of this Section consists of miscellaneous metals, and ornamental iron where shown on the Drawings, as specified herein, and as required for a complete and proper installation. Work includes, but is not limited to the following.
- B. Furnish and install:
 - 1. Above ceiling supports for products furnished under other sections.
- C. Perform all drilling and cutting in miscellaneous metal items required for the attachment of other items.
- D. Perform all shop priming for all surfaces of exposed to view galvanized and non-galvanized metals, and post-erection touch-up of shop prime coat, using the same material as shop-prime coating.
- E. Perform application of liquid zinc touch-up to all welds of galvanized steel items furnished hereunder.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 09 90 00 - PAINTING: Applied finish coatings other than those specified herein.

1.3 REFERENCES

- A. Referenced Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. The standards referenced herein are included to establish recognized minimum quality only. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.
 - 1. ASTM A 36 - Structural Steel.
 - 2. ASTM A 53 – Pipe, Steel, Black and Hot-Dipped, Zinc-coated, Welded and Seamless Steel Pipe.
 - 3. ASTM A 108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold

Finished.

4. ASTM A 123 - Zinc Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars, and Strip.
5. ASTM A 153 - Zinc-Coating on Iron and Steel Hardware.
6. ASTM A 283 - Carbon Steel Plates, Shapes, and Bars.
7. ASTM A 307 - Carbon Steel Externally Threaded Standard Fasteners.
8. ASTM A 325 - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
9. ASTM A 361 - Zinc Coated (Galvanized) Iron or Steel Roofing sheets.
10. ASTM A 385 - Providing High Quality Zinc Coatings.
11. ASTM A 380 - Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
12. ASTM A 386 - Zinc Coating on Assembled Steel Products.
13. ASTM A 446 - Zinc Coated (Galvanized) Steel Sheets of Structural Quality, Coils and Cut Lengths.
14. ASTM A 501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
15. ASTM A 525 - Specification for Sheet Steel, Zinc Coated (Galvanized).
16. ASTM A 780 - Repair of Hot-Dip Galvanizing.
17. ASTM A1011/A1011M - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
18. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
19. ASTM B135 - Specification for Seamless Brass tube.
20. ASTM B36 - Specification for Brass Plate, Sheet, Strip and Rolled Bar.
21. ASTM B455 - Specification for Copper Zinc Lead Alloy (Leaded Brass) Extruded Shapes.
22. ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications.
23. AGAI - Inspection Manual for Hot-Dipped Galvanized Products.
24. AISC - Code of Standard Practice for Steel Buildings and Bridges.
25. AISC - Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.
26. AWS - Standard Code for Arc and Gas Welding in Building Construction.
27. CDA - Standards Handbook, Wrought Copper and Copper Alloy Mill Products, Part 2 - Alloy Data.
28. CDA - Standards Handbook, Cast Copper and Copper Alloy Mill Products, Part 7 - Alloy Data.

29. CDA - Brass and Bronze Design Handbook for Architectural Applications.
30. FS QQ-R-571 - Rod Welding Copper and Nickel Alloy
31. MIL-P-21035B - Paint High Zinc Dust Content, Galvanizing Repair (Metric) (superseding DOD-P-21035A)
32. SSPC referenced standards.
33. NAAMM publication AMP 500 – Metal Finishes Manual
34. NAAMM publication AMP 510 – Metal Stairs Manual.
35. NAAMM publication AMP 521 – Pipe Railing Manual
36. NAAMM publication AMP 555 – Code of Standard Practice for The Architectural Metal Industry.
37. SSPC standards referenced herein, including:
 - a. SSPC-SP1, Surface Preparation – Solvent Cleaning,
 - b. SSPC-SP2, Surface Preparation – Hand Tool Cleaning.
 - c. SSPC-SP3, Surface Preparation – Power Tool Cleaning
 - d. SSPC-SP8, Surface Preparation - Pickling.
 - e. SSPC-Paint 20, Zinc-Rich Coating (Type 1) Inorganic and (Type II) Organic.
 - f. SSPC-Paint 29, Zinc Dust Sacrificial Primer Performance.

B. Definitions:

1. AESS: Architectural Exposed Structural Steel. Includes all exposed-to-view fabricated steel elements furnished under the scope of this Section 05 50 00.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work of this subcontract with that of other trades, affecting or affected by this work, and cooperate with the other trades as is necessary to assure the steady progress of work.
2. Be responsible for establishing locations and levels for all work of this Section, except such parts as may be delivered to others and set by them. In such cases assist them in properly locating said parts.

B. Sequencing: Do not order or deliver any materials until all submittals, required in the this Specification Section have been received and approved by the Architect.

C. Scheduling: Before proceeding with installation work, inspect all project conditions and all work of other trades to assure that all such conditions and work are suitable to satisfactorily receive the work of this Section and notify the Architect in writing of any which are not. Do not proceed further until corrective work has been completed or waived.

D. Field Measurements

- a. Take field measurements before preparation of shop drawings and fabrication, where possible, to ensure proper fitting of Work.
- b. Allow for adjustments within specified tolerances wherever taking of field measurements before fabrication might delay Work.

- F. Scheduling:
1. Coordinate the work of this Section with the respective trades responsible for installing inserts and anchorages furnished by this Section; make arrangements for delivery, receipt and installation of inserts and anchorages to prevent delay of the Work.

1.5 SUBMITTALS

- A. Information and Review Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
1. Product Data: Manufacturer's complete product data and specifications for all prefabricated items, shop primer paints, liquid zinc coating, and hydraulic cements, to be furnished hereunder.
 - a. For epoxy anchoring systems: Furnish ICC-ES Code approvals and performance data that includes recommended loading for each application.
 2. Shop Drawings, bearing registration stamp of a Professional Structural Engineer registered in State of Rhode Island.
 - a. General requirements:
 - 1) Include large scale details of items of all metal fabrications to be furnished hereunder, showing proposed methods of anchorage to surrounding structure and conditions.
 - 2) Indicate on the shop drawings all erection marks for various places of miscellaneous metals, and ensure that the actual field pieces bear corresponding marks.
 - 3) Indicate shop built components, and field-built components.
 - 4) Indicate and detail all field installation connections.
 - 5) Indicate weld types and length.
 - 6) Indicate blocking locations.
 - b. Include large scale details of metal fabrications supporting work of other trades.
 3. Selection Samples:
 - a. Sample card indicating Manufacturer's full range of colors of shop applied finishes available for approval by Architect.
 4. Verification Samples: Accepted samples will be used to establish the quality standard for fabrication, workmanship and finish.
 - a. Factory/shop finishes: 3 inch by 6 inch samples of factory-applied coatings and colors proposed for use for approval prior to coating application.
 - b. Provide minimum 24 by 24 inch (or equivalent for shapes) of fabricated and finished ornamental metal components, demonstrating the quality of fabrication work, and finish.
 - c. Provide 12 inch sections of fabricated and finished AESS metal components, demonstrating the quality of welds and finish.

- d. Provide a sample board of weld, joining and termination conditions to be used for all AESS fabrications and for samples of exposed to view welding conditions demonstrating NOMMA Weld Level 1 (no visible welds).
 - 5. Certificates:
 - a. Certificate of Compliance from Galvanizer: Submit notarized Certificate of Compliance with application for payment for galvanizing, signed by galvanizer, indicating compliance with requirements of specifications. Include scope of services provided, and quantity and itemized description of items processed.
 - b. Welders certificates as specified under Article entitled "QUALITY ASSURANCE".
 - 6. Delegated Design Submittals: Provide calculations for loading and stresses for the work of this section, bearing the Professional Structural Engineer's seal. Show how design load requirements and other performance requirements as required by the *International Building Code, 2012 edition*, as published by the International Code Council, Inc. (I.C.C.), as revised by *RHODE ISLAND STATE BUILDING CODE, Regulation SBC-1 2013 edition*, effective July 1, 2013 have been satisfied.
 - a. Work scope requiring loading and stress calculations includes, but is not limited to the following:
 - 1) Stairs, intermediate landings.
 - 2) Railings including those mounted in glass panels. Coordinate engineering requirements with Section 08 80 00 – GLAZING and incorporate loading limits of glass panels in railing calculations.
 - 3) Metal fabrications supporting work of other trades.
 - 4) Seismic restraints.
 - 5) Ledge and shelf angles.
 - 6) Ladders.
 - 7. Sustainable Design Submittals:
 - a. Provide the following LEED submittal items:
 - 1) All relevant supporting documentation, as required by LEED v4 and as detailed in Section 01 81 13 - SUSTAINABLE DESIGN REQUIREMENTS.
 - 2) A completed LEED Materials Reporting Form, per Section 01 81 13 -SUSTAINABLE DESIGN REQUIREMENTS.
 - B. Closeout Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS.
 - 1. Special Inspections: Submit prior to request for Certificate of Occupancy, to both Architect and local Building Official having jurisdiction, the following:
- 1.6 QUALITY ASSURANCE
- A. General: Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
 - 1. Galvanizer's tagging: The galvanizer shall mark all lots of material with a clearly

visible stamp or tag indicating the name of the galvanizer, the weight of the zinc coating, and the applicable ASTM Specification Numbers.

- B. Exposed Fabricated Steel Elements including stairs, railings, ornamental fabrications and exposed to view fabrications shall be fabricated and finished as Architectural Exposed Structural Steel (AESS) meeting tolerances and fabrication requirements as specified herein.
- C. Qualifications:
 - 1. Welders: Utilize only qualified welders employed on the Work. Submit verification that Welder's are AWS D1.1 and D1.4 qualified within the previous 12 months.
 - 2. Licensed Professionals: Provide the services of a Professional Structural Engineer, registered in the State of Connecticut to design and certify that the work of this section meets or exceeds the performance requirements specified in this section and as required by *International Building Code*, 2012 edition, as published by the International Code Council, Inc. (I.C.C.), as revised by *RHODE ISLAND STATE BUILDING CODE*, Regulation SBC-1 2013 edition, effective July 1, 2013..
 - a. Prepare Shop Drawings for under direct supervision of a same Engineer experienced in design of this work.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Do not order or deliver any materials until all submittals, required in the listed Specification Sections included as part of this subcontract, have been received and approved by the Architect.
- B. Storage and Handling Requirements:
 - 1. Handle and store materials under cover in a manner to prevent defacement, deformation, or other damage to the materials and to shop finishes, and to prevent the accumulation of foreign matter on the metal work. All such work shall be repaired and cleaned prior to erection.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: All materials shall be new stock, free from defects impairing strength, durability or appearance, and of best commercial quality for each intended purpose. Unless specifically called for otherwise, work shall be fabricated from the following:
 - 1. Steel shapes, plates and bars: ASTM Designation A 36.
 - 2. Steel pipe: ASTM A53, grade A, seamless pipe, black finish unless otherwise noted.
 - 3. Structural steel tubing, square and rectangular shapes: ASTM A500, Grade B.

4. Steel tubular shapes: ASTM A 501.
 5. Steel plates to be bent or cold-formed: ASTM A283, grade C.
 6. Steel bars and bar-size shapes: ASTM A36.
 7. Cold-finished steel bars: ASTM A108.
 8. Galvanized carbon steel sheets: ASTM A526, with G90 zinc coating in accordance with ASTM A525.
- B. Steel materials: to be hot dip-galvanized: Provide steel chemically suitable for metal coatings complying with the following requirements: Carbon below 0.25 percent, silicon below 0.24 percent, phosphorous below 0.05 percent, and manganese below 1.35 percent. Notify galvanizer if steel does not comply with these requirements to determine suitability for processing.
- C. Metal surfaces, general: For metal fabrications exposed to view upon completion of the Work, provide materials selected for their surface flatness, smoothness and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.
- D. Welding rods: AWS E70XX grade, or select in accordance with AWS specifications for the metal alloy to be welded and in accordance with the recommendation of the welding rod manufacturer.
1. Where stainless steel is welded to mild steel, select rods to minimize dilution effects on the stainless steel component.

2.2 UNIVERSAL GRID SYSTEM

- A. Specified Manufacturer: To establish a standard of quality, design and function desired, Drawings and specifications have been based on Unistrut Corporation, Itasca IL.
1. Acceptable Manufacturers and products: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following.
 - a. Unistrut Corporation, Itasca IL., product "Unistrut"
 - b. Cooper US, Inc., Houston TX., product "Cooper B-Line".
 - c. Gleason Partners, LLC., Grand Rapids, MI., product "Strut Channel Systems".
 - d. Thomas & Betts Corporation, Memphis TN, product "Kindorf Superstrut".
 2. There are no other manufacturers of this product type available in the United States, fabricators may choose to fabricate grid system components using structural steel shapes, with submittal and approval of complete engineering Drawings and calculations as a substitution.
 3. Finish:

- a. Rust inhibiting acrylic enamel paint applied by electro-deposition, after cleaning and phosphating, and thoroughly baked. Color is per Federal Standard 595a color number 14109 (dark limit V-). Finish to withstand minimum 400 hours salt spray when tested in accordance with ASTM B 117.
- B. All channel members shall be fabricated from structural grade steel conforming to the following ASTM specifications:
 1. ASTM A 653 Grade A
- C. All fittings shall be fabricated from steel conforming to one of the following ASTM specifications:
 1. ASTM A 36, A 575, or A 576.
- D. Provide $\frac{3}{4}$ inch diameter galvanized threaded rod and support assemblies at existing roof joists. Refer to Drawings.
- E. All materials shall be stamped and identifiable by manufacturer and part number (where appropriate). Materials that appear damaged, distressed, unidentifiable or rusted shall not be used and will not be accepted.

2.3 FASTENERS

- A. General: Provide all fasteners and attachments as required for work specified herein and as indicated on the Drawings.
 1. In general,
 - a. Provide all fasteners and attachments of the same material and finish as the metal to which it is applied unless otherwise noted.
 - 1) Provide Type 304 stainless-steel fasteners for exterior use.
 - 2) Provide Type 304 stainless-steel fasteners for fastening aluminum.
- B. Steel Bolts, Nuts and Washers: ASTM A307, galvanized to ASTM A153 for galvanized components.
- C. Anchor Bolts: ASTM F 1554, Grade 36.
 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
- D. Eyebolts: ASTM A 489.
- E. Machine Screws: ASME B18.6.3.
- F. Lag Bolts: ASME B18.2.1.
- G. Wood Screws: Flat head, ASME B18.6.1.
- H. Plain Washers: Round, ASME B18.22.1.

- I. Lock Washers: Helical, spring type, ASME B18.21.1

2.4 ACCESSORIES

- A. Primer for non-galvanized steel surfaces, modified alkyd rust-inhibitive, high solids primer:
 - 1. Products which may be considered as equal include the following, or approved equal:
 - a. Benjamin Moore product: "Metal Primer KP14-70", Gray Primer.
 - b. Rust-Oleum: 6100, Gray Primer.
 - c. Sherwin Williams: Kem Flash 500 Primer, Gray Primer E61A750.
 - d. Tnemec: V10-1009 Gray Primer.

2.5 FABRICATION - GENERAL

- A. Metal surfaces shall be clean and free from mill scale, flake, rust and rust pitting; well formed and finished to shape and size, true to details with straight, sharp lines, and angles and smooth surfaces. Curved work shall be to true radii. Exposed sheared edges shall be eased.
- B. Shop fabricate items wherever practicable, accurately fitting all parts and making all joints tight. Do not fabricate materials until all specified submittals have been submitted to, and approved by, the Architect.
- C. Do all cutting, punching, drilling, and tapping required for attachment of anchor bolts and other hardware and for attachment of work by other trades. All such work shall be done prior to hot-dip galvanizing of the various components.
- D. Grind all edges of bars and plates completely free from nicks and machine marks, prior to galvanizing and/or shop priming.
 - 1. Fabricate AESS with exposed surfaces smooth, square and of surface quality consistent with the approved mock up or samples (as appropriate).
- E. Grind all exposed-to-view welds completely smooth and flush to the surface plane of the base metals. Perform welding work prior to galvanizing in all cases, except where field welding is necessary, in which case, completely coat all such welds with two coats of specified liquid zinc coating, after performing grinding operations.
 - 1. Finish welds on exposed to view components to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.
- F. Use screws and bolts only where welding cannot be performed, of sufficient size to ensure against loosening from normal usage of miscellaneous metal items furnished hereunder.
 - 1. Countersink all screw heads and bolt heads as far as practicable. Use not less than two screw, bolts, or other anchorage items, at each connection point.

2. Draw up all threaded connections tightly, after buttering same with pipe joint compound, to exclude water.
- G. Provision for Thermal Movement: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 1. Design, fabricate and install for temperature change range of 120 degrees F, ambient temperature and 180 degrees F, material surfaces.
- H. Carefully coordinate the installation of metal fabrications with the work of trades responsible for the installation of interfacing work, and for the installation of work into the various assemblies furnished hereunder, and permit the installation of the related materials to be made at the appropriate times.
- I. Fit and assemble metal fabrications in largest practical sections for delivery to site, ready for installation.
 1. Galvanized assemblies: Where size of assembly is too large for galvanizing kettle, galvanize components prior to fabrication and assemble after galvanizing.

2.6 FABRICATION - SUPPORTS

- A. Design, engineer and fabricate structural overhead support for equipment, furnishings, and products furnished under Sections, which includes, but is not limited to:
 1. Above ceiling support for products furnished under other sections.
- B. Fabricate support system to carry the entire load of supported products to building structure above without transferring any horizontal or vertical load to ceiling system(s). Provide frequently spaced holes for multiple adjustment. Provide diagonal bracing. Use of a "Universal Grid" system members is acceptable.
- C. Fabricate supports for equipment, fixtures, and appurtenances utilizing a "Universal Grid" system with rails extending wall-to-wall, perpendicular to the path of travel of the same.
 1. Design, engineer and fabricate supporting framework to support a concentrated load at any single point along the exposed rails, as exerted by the equipment to be purchased by the Owner.
 - a. Installed framework shall have a minimum loading safety factor of 2.5, based upon ultimate strength under static loading conditions.
 - b. The concentrated load shall be the maximum that will be encountered by positioning the equipment at the extremities of its travel (maximal load configurations).
 - c. Base loads on the most severe conditions as may be encountered by any of the manufacturers producing equipment for the type of services of the

rooms indicated.

2. Rail shall be on centers as required by equipment manufacturer and allow continuous attachment along any point on the rail.
3. System shall be true, plumb and level to the tolerances indicated, with no more than $1/720^{\text{th}}$ of the span maximum deflection in either plane, when maximum loading conditions are applied due to equipment operations.

2.7 FINISHES - SHOP APPLIED COATINGS

- A. Schedule: Shop applied coatings as indicated on Drawings, and as additionally specified and scheduled in this Section.
- B. For non-galvanized steel surfaces:
 1. Surface preparation prior to priming: Thoroughly clean all steel of all loose mill scale by power wire brushing or sandblasting. Remove all rust, dirt, weld flux, weld spatter, and other foreign matter by wire-brushing or scraping (power wire-brushing, if necessary). Grind smooth any sharp projections.
 2. Shop apply specified primers thoroughly and evenly on the surfaces and worked into the joints and other open areas on the surfaces. Surfaces inaccessible after assembly shall be given two coats. Dry film thickness of primer shall be not less than 2.4 mils per coat.
- C. Powder coat finish:
 1. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 - a. TIGER Drylac, Reading PA.
 - b. PPG Powder Coatings Division, Pittsburgh PA.
 - c. Powder Technology, Inc., Schofield, WI.
 2. Preparation Four step acidic cleaning treatment:
 - a. Acidic degreasing.
 - b. Water rinse.
 - c. Chromating
 - d. Water rinse.
 3. Preparation Etch and epoxy prime coat:
 - a. Sandblast to white metal for removal of scale, oil and debris to create a minimum 2mil etching for proper adhesion.
 - b. Electrostatic application of epoxy powder primer and heat cure.
 4. Powder coating epoxy coating, as manufactured by TIGER Drylac, Reading PA, Product Special Series 49 in smooth low-semi-gloss finish or approved equal.
 - a. Film Thickness: 2.5-3.5 mils, dry film thickness.
 - b. Gloss: 36-54 (per Gardner 60, ASTM D523).

- c. Cross hatch adhesion test (per ASTM D3359): rated 5B.
 - d. Mandrel bending test (per ASTM D522) 5mm (3/16 inch).
 - e. Impact test (per ASTM D2794), Up to 120 in-lb.
 - f. Pencil Hardness (ASTM B3363) 2H (minimum).
 - g. Humidity resistance, maximum blistering (1500 hours, ASTM D2247): 1 mm (0.04 inch).
 - h. Acid salt spray resistance, maximum undercutting (1500 hours, ASTM G85): 1 mm (0.04 inch).
5. Minimum Film Thickness, Finish Coat: 2.5-3.5 mils, dry film thickness.
 6. Color: Custom color to match Architect's control sample.
 7. Field touch-up: Shall be the responsibility of the installing contractor and shall include the filling, and touch-up of exposed job made nail or screw holes, refinishing of raw surfaces resulting from job fitting, repair of job inflicted scratches and marks, and final cleaning up of the finished surfaces.
- D. Field touch-up: Shall be the responsibility of the installing contractor and shall include the filling, and touch-up of exposed job made bolt or screw holes, refinishing of raw surfaces resulting from job fitting, repair of job inflicted scratches and marks, and final cleaning up of the finished surfaces.
1. Touch-up finishes shall be fully compatible with, and exactly match shop applied finish, color, texture and sheen.
- E. Interior bronze railings finish: Shop finish all bronze elements, ANSI/BHMA A156.18-2012 Materials and Finishes designation 613 "Dark Oxidized Satin Bronze, Oil Rubbed," (former Equivalent US10B).

PART 3 - EXECUTION

3.1 ERECTION - GENERAL

- A. General: Accurately set all work to established lines and elevations, and rigidly fasten in place with suitable attachments to the construction of the building. At the completion of the work, check all work, re-adjust as required, and leave in perfect condition. Grind all exposed to view welds smooth to the touch.
- B. Miscellaneous framing and supports: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and additional requirements indicated on Shop Drawings.
 1. Anchor supports for operable partitions, and similar products, securely to and rigidly braced to building structure.

3.3 FIELD WELDING

- A. Field weld components indicated on approved shop drawings in accordance with AWS D1.1. Weld profile, quality, and finish shall be consistent with approved samples and mock-ups.
1. Welds ground smooth: Erector shall grind welds smooth in the connections of AESS members. For groove welds, the weld shall be made flush to the surfaces of each side and be within + 1/16", -0" of plate thickness.
 2. Contouring and blending of welds: Where fillet welds are indicated to be ground contoured, or blended, oversize welds as required; grind to provide a smooth transition and to match profile on approved mock-up .
 3. Continuous Welds: Where noted on the drawings, provide continuous welds of a uniform size and profile.
 4. Minimize Weld Show Through: At locations where welding on the far side of an exposed connection occurs, grind distortion and marking of the steel to a smooth profile with adjacent material.
- B. Immediately after welding, touch-up welds, burned areas and damaged surface coatings.
1. Thoroughly remove all spatter by power wire-brushing (or if inaccessible, wire brushing) per SSPC, surface preparation specification SP2 or SP3. Allow surface to cool to ambient temperature. Clean surface with solvent wipe to remove oils, grease and dirt in accordance with SSPC surface preparation specification SP1.
 2. Apply one coat of liquid zinc to attain a minimum of 1.5 mils dry film thickness. Coating should extend at least two inches beyond either side of weldment to ensure complete coverage of welded area.

3.4 FIELD BOLTING

- A. Accurately drive all bolts into holes, protecting the bolt heads so as not to damage the thread during the driving. Ensure that bolt heads and nuts rest squarely against the metal. Where structural members have sloping flange faces, provide approved beveled washers at the bolted connections to afford square seating for bolt heads or nuts. Nick bolt threads for unfinished bolts to prevent the nuts from backing off.
1. Bolt Head Orientation: All bolt heads shall be oriented as indicated on the contract documents. Where bolt-head alignment is specified, the orientation shall be noted for each connection on the erection drawings. Where not noted, the bolt heads in a given connection shall be oriented to one side.
- B. Use an approved calibrated manual or power torque wrench to obtain the proper torque and tension as recommended by the bolt manufacturer for all ASTM A 325 bolts.

3.5 TOUCH-UP

- A. Touch-up all welds, burned areas, scratches, abrasions, on galvanized metals, using specified liquid zinc coating.
- B. Touch-up all welds, scratches, abrasions, and other surface damaged on shop- primed or painted metals, using the same coatings as specified under shop applied finishes, herein above.

3.6 SUPPLEMENTAL SCHEDULES

- A. General: Items listed herein below provide further description of those already indicated in the Drawings. This list does not represent a complete list of miscellaneous metal components or types required to complete the Work.
 - 1. Carefully review all Drawings and furnish and install metal fabrications required by the various trades, whether or not specifically listed herein, such as miscellaneous clip angles, miscellaneous steel bracketing, and other

End of Section 05 50 00

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SECTION 05 70 00 – DECORATIVE METAL**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Extent of column covers system as shown on drawings
- B. Linear grille below protruding walls at existing windows.

1.3 ACTION SUBMITTALS

- A. Submit complete shop drawings indicating quantities, dimensions, finishes, and attachment details.
- B. Submit manufacturers product data, specification, and installation instructions.
- C. Submit color and finish samples to verify color, pattern and finish specified. Standard sample sizes are 3.5" x 5" and 5" x 7".

1.4 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of 5 years experience in manufacturing architectural metals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the project site in manufacturer's original packaging, properly labeled for identification and installation purposes.
- B. Store in location to avoid damage from job-site traffic, direct sunlight, moisture, stacking or other job-site contaminants.
- C. Handle components to avoid denting or scratching of finished surfaces.

1.6 WARRANTY

- A. Provide manufacturer's warranty against defects in material and workmanship for a period of one year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer Column Cover : Móz Designs, Inc.

1. 711 Kevin Court, Oakland, CA 94621
2. Phone 510-632-0853
3. Fax 510-632-0852
4. Email: estimating@mozdesigns.com

B. Basis of Design Manufacturer linear Grille: Architectural Grille.

2.2 MOZ METAL COLUMN COVERS

A. MATERIAL:

1. .090" Aluminum: Type 5052 alloy complying with ASTM B209 OR
2. 18 GA Stainless Steel: Type 304 stainless steel, complying with ASTM A789

2.3 PRE-FINISHED BY MANUFACTURER

1. See Materials List on Drawings for MTL designations
2. Finish: Polycoat Gloss (GL) or Matte (MA), Durafilm Satin, Tuffcoat, Powder coat, Duranar, Or Embossed Stainless.
3. Provide factory applied removable plastic film for protection during fabrication and installation.

2.4 Basis of Design: MOZ CC150 SQUARE SERIES COLUMN COVERS, OR

A. See drawings for details

1. Full Surround in 2 Sections
 - a. 2 sections engraved. Pattern: "Circuit" – horizontal
 - b. 2 sections laser-cut. Patterns: "Cyber"
 - c. Color: Nickel
2. Width/Diameter/Size: consistent for all columns; see drawings
3. Overall Height: see drawings; coordinate with base and top details
4. Vertical butt joints (VBJ)
5. Recessed Base 4-sided cover 9" H: Gray Sand Powder Finish
6. Recessed Capital 4-sided cover: 9"H +/- Gray Sand Powder Finish

B. LED strip

1. Per manufacturers standard supplier supplier.
 - a. Coordinate with electrical contractor.
2. Controls:
 - a. Wall mounted controller in the control alcove.
 - b. Additionally, the light fixtures shall be tied into the AV control system. Coordinate with the AV contractor and provide the appropriate modules.
 - c. The AV controls shall override the manual control.

C. Acrylic diffuser lens.

- a. As shown on the drawings.

2.5 LINENEAR GRILLE

A. Basis of Design

1. Architectural Grille, Manuf. AG 10 Bar Grille
 - a. Spackle-in frame, "AG10 I Frame"
 - b. Aluminum, satin finish

c. 36"x4"

2.6 FABRICATION

- A. Column manufacturer to pre-form column covers to specified dimensions and diameters as indicated on shop drawings.
- B. Provide column covers in sections a maximum 12' 0" tall per section.
- C. Columns shall have no exposed fasteners unless specified.
- D. Provide additional bracing components as necessary to stiffen substructure and insure solid mid-span bracings and connections. (By others)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine job-site conditions for conditions that may adversely affect installation of column covers.
- B. Verify dimensions of column covers prior to installation to assure compatibility with job-site conditions.
- C. Verify post structure is plumb, level, and parallel prior to installation of column covers.
- D. Visually examine finished surfaces to assure that blemished or dented surfaces are not present prior to installation.

3.2 PREPARATION

- A. Verify/coordinate with other trades prior to installation insofar as they are affected by column cover installation.

3.3 INSTALLATION

- A. Install components in accord with manufacturer's installation instructions and approved shop drawings.
- B. Anchor components to related structures such as floors, walls and beams as indicated on approved shop drawings. Use anchors with holding strength to provide a solid installation. Use only plated, galvanized or stainless steel anchors.

3.4 CLEANING

- A. Remove protective coverings and clean column covers to remove adhesives and tape residue. Test all solvents on non-exposed surfaces prior to use.

1. For painted surfaces, use a mild detergent solution on a soft cloth.
 2. For stainless steel, use a glass cleaner and a soft cloth.
 3. For other surfaces, contact manufacturer for proper cleaning procedures.
- B. Visually inspect all exposed surfaces for scratches or blemishes.
- C. Protect column covers from damage during remainder of construction period.

END OF SECTION 05 70 00

SECTION 06 10 00 ROUGH CARPENTRY**PART 1 - GENERAL**

1.1 SUMMARY

- A. The work of this Section consists of rough carpentry where shown on the Drawings, as specified herein, and as required for a complete and proper installation. Work includes, but is not limited to the following.
- B. Furnish and install the following:
 - 1. Fire retardant treated plywood backer panels for mounting of AV equipment, electrical panelboards, telephone/data backboards, HVAC and fire control equipment and other equipment.
 - 2. Various wood blockings, edgings, nailers, curbs, cants, grounds, furring, sheathing, framing members including wood preservative or fire-retardant treated as indicated, for receipt of various finishes and surfacing materials, not described herein above.
 - 3. Rough installation hardware, including bolts, screws, spikes, nails, clips, and connection assemblies, as needed for installation of the rough carpentry work.
 - a. Provide epoxy set 'restoration' anchors.
- C. Install the following furnished under the designated Sections:
 - 1. Metal door frames furnished under Section 08 11 13 - HOLLOW METAL DOORS AND FRAMES.
 - a. Place frames and erect in correct positions within specified tolerances.
- D. Coordinate work of this Section with the work of the various trades responsible for applying finish materials and other items to rough carpentry work. Furnish and install furring, blocking, and shims, and other usual items of normal rough carpentry work as required by the various trades for the proper completion of the project.
 - 1. The applicable requirements specified in Part 1 - GENERAL and Part 3 - EXECUTION of the individual specification sections furnishing materials to be installed under this Section, shall be included in and made a part of this Section.
- E. No attempt is made in this Section to list all elements of rough carpentry required on this project or to describe how each element will be installed. It is the responsibility of the Contractor to determine for itself the scope and nature of the work required for a complete installation from the information provided herein and in the Drawings.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 08 11 13 - HOLLOW METAL DOORS AND FRAMES: Furnishing hollow metal framing.
- D. Section 09 21 20 - GYPSUM BOARD ASSEMBLIES: Wallboard construction work, having taped and compounded joint finish.
- E. Section 09 91 00 - PAINTING AND COATINGS: Applied primer and finish coatings to exposed to view rough carpentry work.
- F. Division 26 - ELECTRICAL: Providing and mounting electrical panels and equipment.
- G. Coordinate with AV vendors to coordinate block for wall mounted devices.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. APA - applicable grades and specifications.
 - 2. APA PRB-108 Performance Standards and Policies for Structural-Use Panels.
 - 3. ANSI A250.11 (formerly SDI 105) - Recommended Erection Instructions for Steel Doors and Frames.
 - 4. ASTM D 3201 - Test Method for Hygroscopic Properties of Fire-Retardant Wood.
 - 5. AWPA Standards and references for preservative treated wood including Standards UC1, UC2, UC3A, UC3B, UC4A, and P5
 - 6. AWPA Standard UCFA – Fire Protection as Required by Codes Above Ground Interior Construction.
 - 7. AWPA Standard UCFB – Fire Protection as Required by Codes Above Ground Exterior Construction.
 - 8. AWPA M4 – Care Of Preservative Treated Wood Products.
 - 9. NER-643: ACQ Preserve® and ACQ Preserve Plus® Wood Preservative Treatment, ICBO Evaluation Service.
 - 10. MIL L-1914OE - Lumber and Plywood, Fire Retardant Treated.
 - 11. PS-56 - Structural Glued Laminated Timber.
 - 12. SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and

Frames.

13. SPIB Grading Rules, current edition.
14. UL - Building Materials Directory
15. US. Department of Commerce Voluntary Product Standard PS1 for Construction and Industrial Plywood.
16. US. Department of Commerce Voluntary Product Standard PS2 for Wood-Based Structural-Use Panels.
17. US. Department of Commerce Voluntary Product Standard PS-20 - American Softwood Lumber Standard.
18. U.S. Department of Commerce Simplified Practice Recommendation R-16, for sizes and use classifications of lumber
19. American Lumber Standards Committee, National Lumber Grades Authority for Canadian Lumber, and applicable grading rules and standards of the various lumber associations whose species are being used for grades specified.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work of this Section with the respective trades responsible for locating anchorages installed into blocking which is provided under this Section.
2. Coordinate work of this Section with the work of the various trades responsible for applying finish materials and other items to rough carpentry work, and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.

1.5 SUBMITTALS

A. Information and Review Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:

1. Product Data: Manufacturer's product data sheets, specifications, performance data, physical properties and installation instructions for products specified herein.
2. Certifications:
 - a. Written certification from the respective treatment plants indicating types of wood preservative treatment and fire-retardant treatment used, treatments method, applications instructions, and conformance to the requirements specified herein.
 - 1) Provide certification that fire retardant treatment materials do not contain ammonium phosphate.
 - 2) Provide report from ICC Evaluation Service on fire retardant treated wood flame spreading, strength, corrosion and hygroscopic properties.
 - 3) Provide report from ICC Evaluation Service on pressure preservative treated wood strength, corrosion, anti-fungi, and anti- insect properties.

- b. Urea-formaldehyde Resins: Written documentation certifying that all composite wood and agrifiber products used on this Project contain no added urea-formaldehyde.
 - 1) Written certification from Millworker, that only "no added urea-formaldehyde" manufactured composite panel products are incorporated into the Work, including all concealed components. Composite panel products include but are not limited to particle board (PB), Medium Density Fiberboard (MDF) and similar manufactured products.
 - 2) Written certification from Millworker that laminating adhesives used in product fabrication on or off site do not contain any added urea-formaldehyde resins.

1.6 QUALITY ASSURANCE

- A. General: Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
 1. All lumber shall:
 - a. Be new, dressed four sides (S4S), clear and free from warping and other defects.
 - b. Have a moisture content not exceeding 19 percent when delivered to the project.
 - c. Be in accordance with the grading rules of the lumber manufacturer's association under whose jurisdiction the lumber is produced and bear the mark of grade and mill identification.
- B. Certifications:
 1. Plywood: Conform to the requirements of Product Standard PS-1, and bear applicable APA grade trademarks.
 - a. Plywood for electrical boards treated for retardance, meet Class I or a flame spread rating of 25 or less and bear U.L. label "Classified FRS".

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements:
- B. Store all materials in an elevated dry location, protected by waterproof coverings.

1.8 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 BOARD AND SHEET MATERIALS

- A. Lumber for blocking, nailers and curbs as indicated or required: Hem-Fir, Douglas Fir, Eastern Spruce, Eastern Hemlock, or Southern Pine, surfaced dried stud or utility grade. Wood members shall be of sizes indicated on the Drawings or of the same size as the members being braced.
 - 1. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
 - 2. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.
- B. Furring: Nominal 1 by 3 inches or 1 by 4 inches Douglas Fir, Eastern Spruce, Eastern Hemlock, or Southern Pine, surfaced dried construction grade.
- C. Plywood and sheet products:
 - 1. For substrate beneath gypsum board: Square edge APA graded C-D-X EXT, touch-sanded, 3/4 inch thick, except as otherwise indicated on the Drawings
 - 2. For electric panel board mountings and similar uses: APA graded B-D INT, Group 2 species, touch-sanded, fire-retardant treated, 3/4 inch thick, except as otherwise indicated on the Drawings.
 - 3. For unspecified interior concealed from view locations: APA graded C-D PLUGGED INT, Group 2 species, thickness as indicated on the Drawings.
 - 4. Exterior plywood: 3/4 inch thick APA graded B-C, Exposure 1, EXT, Group 1 species, 5 ply/5-layer plywood, touch sanded.

2.2 WOOD TREATMENTS

- A. Treated wood products shall be produced by a single treatment plant, fully licensed by the chemical manufacturers, and conforming to the requirements specified herein.
 - 1. Toxicity and Environmental Quality:
 - a. Products containing chromium will not be permitted.
 - b. Products containing arsenic will not be permitted.
 - c. Fire-retardant-treated wood products shall be free of halogens, sulfates, ammonium phosphate and formaldehyde.
 - 2. Dye wood or otherwise color code all treated wood at treatment plant to clearly distinguish the different treatments in the field.
 - 3. Kiln dry all treated lumber and plywood to the following maximum moisture content after treatment.
 - a. Lumber: 19 percent.
 - b. Plywood 15 percent.
 - c. Discard pieces with defects which might impair quality of work.
 - 4. Quality marks: Each piece of lumber and plywood shall be permanently affixed with a quality mark, containing the following information:
 - a. Identification of the inspection agency.

- b. Standard to which material was treated.
 - c. Identification of the treating plant.
 - d. Fire retardant treated wood shall include: stamp signifying a FR-S rating
 - e. Preservative treated wood shall include: Retention and end use for which product is suitable.
- B. Fire retardant treated wood. Designated as "FRTW"
1. Chemical Manufacturer: Subject to compliance with the requirements specified herein, Products which may be incorporated in the work include:
 - a. Arch Wood Protection, Atlanta, GA., product, "Dricon FRT Wood".
 - b. Osmose, Inc., Griffin GA., product "FirePro".
 - c. Hoover Treated Wood Products, Inc., Thomson, GA product "PyroGuard".
 - d. Viance, LLC., Charlotte, NC, product: "D-Blaze FRT".
 2. Fire retardant treated wood shall comply with the following requirements:
 - a. All fire-retardant lumber and plywood must have an Underwriters Laboratories stamp signifying a FR-S rating certifying a 25 or less flame spread and smoke developed value, when tested in accordance to ASTM E-84, or UBC Standard No. 42-1.
 - b. Corrosion rates: Less than one mil per year for carbon steel, galvanized steel, aluminum, copper and red brass in contact with the fire retardant treated wood when tested in accordance with Federal Specification MIL- L-19140E Paragraph 4.6.5.2.
 - c. The fire retardant treated wood must have an equilibrium moisture content of not more than 25 percent when tested in accordance with ASTM D 3201 procedures at 95 percent relative humidity and 80 degrees Fahrenheit.
 - d. Fire retardant chemical: Registered for use as a wood preservative by the U.S. Environmental Protection Agency.
 - e. Testing: Fire performance and strength properties for both lumber and plywood, of the fire retardant treated wood shall be recognized by issuance of a ICC Evaluation Service Report. Fire retardant chemical must not damage the middle lammella of the wood structure when exposed to 170 degrees Fahrenheit and 90 percent relative humidity for 23 days.

2.3 ACCESSORIES

- A. Adhesives:
1. General: Provide adhesives approved which are Low-VOC or non-VOC, non-flammable, water-proof after cured, odor free, and comply with CHPS certification requirements.
 2. Adhesive for lamination and fabrication of wood and plywood items: Exterior adhesives containing no urea formaldehydes, having a VOC limit of 70 g/L.

3. Adhesive for subfloors and underlayment: High strength, waterproof and non-freezing adhesive complying with AFG-01 "Frozen Lumber Test" and ASTM 3498, and having a VOC limit of 50 g/L.
- B. Nails (interior and exterior): Galvanized common nails, of size and type to suit application and as required by state and local building codes.
- C. Screws:
 1. Screws for interior applications: Flat head electroplated-galvanized wood screws of the appropriate sizes.
 2. Screws for exterior applications:
 - a. For ACQ pressure preservative treated wood: Flat head type 304 or 316 stainless steel only, wood screws, of the appropriate sizes. Aluminum, galvanized steel, and coated metal fasteners are prohibited.
 - b. For general application (non-pressure preservative treated wood): Flat head hard aluminum, or stainless steel, wood screws, of the appropriate sizes.
- D. Anchor bolts, expansion bolts and lag screws: Hot-dipped galvanized steel, of the following types:
 1. For lumber having actual thickness of 1-1/2 inches or greater to masonry and concrete: Anchor bolts or expansion bolts, as most applicable for the specific receiving surface material, 3/8-inch minimum diameter, spaced as shown on drawings, and staggered as far as practicable. Countersink all bolt heads, and provide head washers of matching material.
 2. For lumber having actual thickness of greater than 7/8-inch but less than 1-1/2 inches to masonry and concrete: Anchor bolts or expansion bolts, as most applicable for the specific receiving surface material, at least 1/4-inch diameter of the most appropriate lengths for the specific application, spaced as shown, and staggered as far as practicable. Countersink all bolt heads, and provide head washers of matching material.
 3. For lumber having actual thickness of 7/8-inch and less: Anchor bolts or expansion bolts, at least 1/4-inch in diameter; or screws, of the most appropriate sizes; in lengths most suitable for the specific application, countersunk, spaced, and staggered.
- E. Protection paper: Canadian red-rosen paper or kraft paper.
- F. Building paper: ASTM D 226, Non-perforated, No. 15 (73 kg/sq m) asphalt-saturated building felt.

PART 3 - EXECUTION

3.1 PREPARATION

- A. All materials shall be inspected before use, with all checked, split and otherwise deficient stock rejected, or used only for miscellaneous blocking, furring or other

incidental use. The Contractor shall be responsible for replacing all lumber which, due to warpage, twist, splitting, or checking, results in unsatisfactory work. Such replacement shall be required at any time, whether before or after application of finish material under other Sections.

- B. Verify exact locations of toilet accessories, door stops and similar items with Architect prior to installation of blocking for accessories.

3.2 INSTALLATION - GENERAL

- A. Closely coordinate the installation of the rough carpentry work with the work of other trades responsible for the installation of interfacing or overlaying materials, so as not to delay the work of the related trades.
- B. Erect all rough carpentry work plumb, level, and true with tight, close fitting joints, securely attached and braced to surrounding construction, all in a first class workmanlike manner. Counterbore for bolt heads, nuts, and washers where required to avoid interference with other materials. Bear complete responsibility for structural integrity, connections, and anchorage of all rough carpentry work.
- C. Make provisions for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- D. Use as long lengths as practicable for wood nailers, blockings, and curbs, to minimize number of joints, and attach the members with the types, and spacing, of fasteners specified herein.
- E. Install blocking, grounds and furring, as required for proper attachment of the work of other trades, in accordance with the requirements provided by the respective related trades.
 - 1. Spacing for furring and strapping shall not exceed 16 inches on center.
- F. Field cuts of fire retardant treated lumber: Do not rip or mill fire retardant treated lumber. Only end cuts, drilling holes and joining cuts are permitted.
- G. Field cuts of ACQ pressure-treated lumber: Apply solution of copper naphthenate containing a minimum of 2 percent metallic copper in-solution, in accordance with AWWA standard M4. Brush liberally all cuts and holes.
- H. Install concealed from view plywood with specified fasteners spaced not more than 10 inches on centers.
- I. Install fire-treated plywood backer boards with counter-sunk galvanized fasteners, of specified sizes, spaced not more than 12 inches on centers.

3.3 INSTALLATION – EQUIPMENT BACKBOARDS

- A. Provide panel mounting backboards for HVAC, Fire Prevention, Electrical and

telephone/data equipment. Fabricate panels using fire-retardant treated 3/4 inch thick panels mounted to fire-retardant treated 2 by 4's. Provide a nominal space of 3-1/2 inches behind panels to permit wiring.

3.4 INSTALLATION - METAL DOOR FRAMES

- A. Place in position all steel frames, furnished under Section 08 11 13 - HOLLOW METAL DOORS AND FRAMES, in accordance with the approved shop drawings and frame schedule. Place, erect and level all frames into correct scheduled locations, including those in masonry partitions.
 - 1. During the installation of metal door frames, after the manufacturer's steel shipping bars have been removed, install wood spreaders at door opening, carefully dimensioned to permit square and plumb installation of door frames and doors.
 - a. Provide rigid temporary bracing for frames as required to ensure maintenance of positioning, and remove only after frames have been permanently anchored.
 - b. For doors located in masonry work, maintain frame position with temporary bracing until frames are built-into-place, and grout has sufficiently cured to maintain frame position.
 - c. Spreaders shall remain in place until doors are installed.
 - 2. Coordinate installation of frames with the various trades installing abutting wall construction for anchor placement.
- B. Coordinate installation of frames with installation of hardware under Section 06 20 00 - FINISH CARPENTRY and as furnished under Section 08 71 00 - DOOR HARDWARE.
- C. Install frames in accordance with the manufacturer's recommendations, ANSI/SDI-100, SDI-105, and the Door Hardware Institute (DHI) recommendations.
 - 1. Secure frames with the following number of anchors per jamb.
 - a. For frames 7'-6" in height or less: 3 anchors per jamb.
 - b. For frames 7'-6" in height or less and having doors exceeding 3'-0" feet width, and for cross corridor frames: 4 anchors per jamb.
 - c. For frames greater than 7'-6", up to 10'-0" in height: 4 anchors per jamb.
 - d. For frames greater than 7'-6", up to 10'-0" in height, and having doors exceeding 3'-0" feet width, and for cross corridor frames: 5 anchors per jamb.
 - e. For frames over 10'-0' in height: 5 anchors per jamb.
 - 2. Secure frames, occurring in existing masonry, with expansion bolts and sleeves.
 - 3. Where exposed fastener heads occur in frames, fill with automotive body filler and sand smooth.

3.5 TOLERANCES

- A. Door frames: Maximum diagonal distortion 1/16 inch measured with straight edge, corner to corner.

3.6 CLEANING

- A. Daily clean work areas by sweeping and disposing of scraps and sawdust.
- B. Upon completion of the work of this Section in any given area, remove tools, equipment and all rubbish and debris from the work area; leave area in broom-clean condition.

3.7 SCHEDULES

- A. Wood treatment schedule:
 - 1. Pressure preservative treat all concealed or exposed-to-view:
 - a. Lumber and plywood which comes in contact with concrete, masonry, or earth.
 - b. Lumber and plywood nailers, blocking and curbing directly related to roofing, flashing, skylights, roof hatches, and roof accessories.
 - c. Lumber and plywood rough-bucks, blocking and nailers directly related to windows, curtainwall and storefront systems.
 - 2. Fire retardant treat all concealed or exposed-to-view:
 - a. Wood blocking, nailers and curbing where indicated or noted on Drawings.
 - b. Equipment backer boards.

- B. Wood blocking schedule: The following schedule lists common items for which blocking is required and may not be indicated on the Drawings. It is not the intention of this schedule to list all conditions requiring blocking or limit the extent of blocking required for completion of the Work; provide all wood blocking, edgings, nailers, required for receipt of various finishes and surfacing materials. Securely anchor wood blocking and run continuous between framing.
 - 1. Blocking sizes indicated below are minimum sizes for conditions which not otherwise sized or indicated on Drawings. In case of conflict, sizes identified on Drawings govern.

Items	Nominal size of blocking with fastener notes
Door Frames, having openings exceeding 4 feet in width;	2 by 4 inch, full height of wall framing

Door frames, cross corridors;	2 by 4 inch.
Door stops, wall mounted;	1 by 3 inch.
Grab bars;	2 by 6 inch, with 1/4 inch dia. toggle bolts.
Lavatories;	3/4 inch plywood extending full height from floor to top of wall framing. Install lavatories with 1/4 inch dia. toggle bolts
Mirrors, framed;	2 by 4 inch
Soap dispensers, wall mounted;	1 by 3 inch
Paper towel dispensers, waste receptacles, feminine napkin dispensers;	1 by 3 inch.
Toilet paper dispensers;	2 by 4 inch
Towel bars;	2 by 6 inch, 1/4 inch diameter toggle bolts
Wall mounted railings;	2 by 8 inch
Window treatment:	2 by 4 inch

End of Section 06 10 00

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06 40 20 INTERIOR ARCHITECTURAL WOODWORK**PART 1 - GENERAL**

1.1 SUMMARY

- A. Install doors and door hardware.

1.2 RELATED REQUIREMENTS

- A. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- B. Section 06 10 00 - ROUGH CARPENTRY: Concealed wood blocking and nailers.
- C. Section 08 14 00 - FLUSH WOOD DOORS:
- D. Section 08 71 00 - DOOR HARDWARE

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 - GENERAL REQUIREMENTS. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. ASTM D 523 - Standard Specification for Specular Gloss.
 - 2. AWI Quality Certification Program.
 - 3. ANSI/HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood.
 - 4. APA Grades and Specifications.
 - 5. National Lumber Grades Authority, American Lumber Standards, and Grading Rules and Standards of the various lumber associations whose species are being used, with grade-marks for same.
 - 6. U.S. Department of Commerce Simplified Practice Recommendation R-16, for sizes and use classifications of lumber; and Product Standard (PS):
 - a. PS-1 - Construction and Industrial Plywood Standard. (on 4/2016 this is still current)
 - b. PS-20 - American Softwood Lumber Standard.
 - 7. Inclusionary References: The following reference materials are hereby made a part of this Section by reference thereto:
 - 8. AWI/AWMAC/WI joint publication: *North America Architectural Woodwork Standards*, version 3.1, as amended by published errata, referenced herein as NAAWS.
- B. Definitions:
 - 1. AWI: American Woodwork Institute.
 - 2. AWMAC: Architectural Woodwork Manufacturers Association of Canada,

Alberta, Canada.

3. HPVA: Hardwood Plywood & Veneer Association.
4. WI: Woodwork Institute.
5. NAUF: No added Urea Formaldehyde.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:

1. Field Measurements: The woodwork manufacturer shall take field measurements before preparation of shop drawings and fabrication to ensure proper fitting of Work.
 - a. Allow for adjustments within specified tolerances wherever taking of field measurements before fabrication might delay Work.
2. Field dimensions which are not controlled by Project conditions: The woodwork manufacturer is responsible for details and dimensions not controlled by Project conditions and shall show on his shop drawings all required field measurements beyond his control.
 - a. The Contractor shall acknowledge the woodwork fabricator's need for accurate field dimensions prior to custom fabrication.
 - b. The Contractor and the woodwork manufacturer shall cooperate to establish and maintain these field dimensions.

B. Scheduling:

1. Coordinate the work of this Section with the respective trades responsible for installing interfacing work, and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.
2. Coordinate schedule of construction, size of access, and route to location of installation to prevent delay of installation due to physical impediments. Any work involving the demolition and reconstruction of partitions, walls, floors, roofing, windows, or doors to place and install the work of this Section shall be performed at no additional cost to the Owner.

1.5 SUBMITTALS

- A. Submit doors and hardware per the referenced sections.
- B. Installation of door hardware only.
- C.

1.6 QUALITY ASSURANCE

- A. Quality Standards: All materials, workmanship and finishes shall meet *AWI/AWMAC/WI NORTH AMERICAN ARCHITECTURAL WOODWORK STANDARDS (NAAWS)*, version 3.1, as amended by published errata, for the following Quality Grades:
 1. All work to receive transparent finishes: Premium Grade.
- B. Qualifications:
 1. Fabricator/Installer: Work of this section shall be performed by a firm licensed by

the AWI Quality Certification Program (QCP).

- a. Contractor shall register the work under this Section with the AWI Quality Certification Program (855-345-0991). Furnish to Architect assigned AWI Project Number.
- b. Woodwork fabricator/installer is required to be licensed by AWI as competent to perform the work specified. Certification shall be evidenced through the application of AWI Quality Certification labels and issuance of an AWI letter of licensing for the project. AWI certification labels shall be applied to each item of work.

1.7 DELIVERY, STORAGE AND HANDLING

A. Delivery and Acceptance Requirements:

1. General: The woodwork manufacturer, woodwork installer and the Contractor are jointly responsible to make certain that woodwork is not delivered until the building and storage areas are sufficiently dry so that the woodwork will not be damaged by excessive changes in ambient humidity and relative moisture content.
2. Concrete, masonry, plaster, tile and marble setting and polishing and other wet work shall be completed and dry before delivery, storage and installation of woodwork items.
3. Sequence deliveries to avoid delays and to minimize on-site storage.

B. Storage and Handling Requirements:

1. Ship and handle all materials and fabricated items in a manner which will prevent damage thereto, and store all materials and fabricated items at a dry, elevated, ventilated, and protected interior location.

1.9 SITE CONDITIONS

- A. Temperature: Maintain ambient temperature above 55 degrees Fahrenheit for 5 calendar days before, and during installation of architectural woodwork; maintain temperature after installation until Owner's Final Acceptance.

- B. Relative Humidity: Maintain a relative humidity between 25 and 55 percent for a minimum period of 5 calendar days before, and during, installation of architectural woodwork; maintain relative humidity after installation until Owner's Final Acceptance.

PART 2 - PRODUCTS**2.1 WOOD MATERIALS – GENERAL REQUIREMENTS**

- A. Not required.
- B. Installation of door hardware only

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Verification of Conditions: Inspect all surfaces and verify that they are in proper condition to receive the work of this Section.
 - 1. Verify adequacy of blocking, backing and support framing for all finish carpentry work.
 - 2. Examine pre-fabricated woodwork before installation and verify that back priming has been completed and all packing has been removed.
 - 3. Beginning of installation means acceptance of existing substrate and project conditions.

3.2 PREPARATION

- A. Before installing work under this section, woodwork shall be conditioned to average prevailing humidity conditions in areas of installation.
- B. Protect other Work against undue soilage and damage by the exercise of reasonable care and precautions. Clean, repair, or replace any work so damaged and soiled to the acceptance of the Architect.

3.3 FIELD FINISHING

- A. Except where expressly noted otherwise on Drawings, shop finish all woodwork. Where field finishing is indicated or scheduled on Drawings, finishing Work shall be as specified under Section 09 91 00 - PAINTING.

3.4 TOLERANCES**3.5 CLEANING**

- A. Daily clean work areas by sweeping and disposing of scraps and sawdust.
- B. Upon completion of the work of this Section in any given area, remove tools, equipment and all rubbish and debris from the work area leave area in broom-clean condition.
- C. Remove protective material from pre-finished surfaces, immediately prior to Final Acceptance.
- D. Carefully clean exposed and semi-exposed wood surfaces, in strict accordance with fabricator's instructions. Touch-up shop-applied finishes to restore damaged or soiled areas, matching adjoining finish.
- E. Wash down plastic laminate with a solution of mild detergent in warm water, applied with soft clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
- F. Clean and polish hardware, and bright metal trim components.

3.6 PROTECTION

- A. Protect installed woodwork and maintain specified conditions, in a manner acceptable to both fabricator and installer. Ensure that work of this Section will not be damaged or soiled, and is completely free of defects at the time of final acceptance of Project by the Architect.

End of Section

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SECTION 07 84 10 PENETRATION FIRESTOPPING**PART 1 - GENERAL**

1.1 SUMMARY

- A. Furnish and install fireproof firestopping, firesafing materials, smoke seals and related accessories required for this Project for all penetrations through fire resistance rated construction, including, but not limited to, penetrations for elevators, plumbing, fire suppression, heating, ventilating and air conditioning, electrical systems, and specialized equipment.
 - 1. Fire resistance rated construction requiring firestopping includes, but is not limited to: floors, rated partitions, smoke barriers, smoke partitions, partitions in rated corridors, passageways and stairs, shaft partitions, shaft wall (vertical and horizontal), area separation fire walls, party wall systems, and temporary fire resistant rated partitions and barriers.
 - 2. Provide removable temporary firestopping (pillows) as required to maintain fire integrity prior to Owner's final acceptance, to permit installation of electrical, telephone, data and sound system wiring. Replace temporary firestopping with permanent, after wiring systems are completed.
- B. Furnish and install firestopping/smoke seals at construction joints occurring where new mechanical piping penetrates the second floor level and the roof level.
- C. Furnish and install firestopping/smoke seals at construction joints occurring at tops of fire resistance rated partitions, smoke partitions, and temporary partitions between top of partition and underside of deck above.
- D. Furnish and install all firestopping, firesafing, and smoke seals at expansion joints in chase walls where expansion joints are not exposed to view.
- E. Furnish and install all firestopping, firesafing, and smoke seals where required by applicable codes and as additionally required by authorities having jurisdiction at no additional cost to the Owner.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 09 21 10- GYPSUM BOARD ASSEMBLIES: Gypsum wallboard fireproofing.
- D. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING: Heating, ventilating and air conditioning system penetrations through fire resistance rated construction.

1.3 REFERENCES

- A. Referenced Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. The standards referenced herein are included to establish recognized minimum quality only. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.
1. ASTM E-84 - Test Method for Surface Burning Characteristics of Building Materials.
 2. ASTM E-119 - Method for Fire Tests of Building Construction and Materials.
 3. ASTM E-814 - Test Method of Fire Tests of Through-Penetration Firestops.
 4. NFPA 70 - National Electrical Code.
 5. UL - Fire Resistance Directory.
 6. UL 1479 - Fire Tests of Through Penetration Firestops.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide materials and work to conform to Building Code Requirements in fire resistant wall and floor assemblies.
- B. Manufacturer's certified product test requirements:
1. All firestop/smokeseal material shall be tested by a recognized, independent testing agency and shall conform to both Flame (F-rating) and Temperature (T-rating) requirements of ASTM E-814.
 2. Conform to UL Fire Hazard Classification Requirements.
 3. Tested and classified non-combustible per ASTM E-84.
- C. Firestops in place shall be of sufficient thickness, width, and density to provide a fire resistance rating at least equal to the floor, wall, or partition construction into which it is installed.
- D. Non-combustible dams shall be constructed:
1. As necessary to achieve fire rating as tested and rated.
 2. In conformance with installation requirements for type of floor, wall, and partition construction.
 3. As recommended by firestop/smokeseal manufacturer.
- E. Combustible damming materials, if used, must be removed after proper curing.

1.5 SUBMITTALS

- A. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS

1. Literature: Manufacturer's product data sheets, specifications, performance data, and physical properties.
 - a. Indicate requirements for manufacturer's descriptive data for products and related materials with FM, UL or Warnock-Hersey illustrations showing systems and approval of materials in systems.
2. Certification: Manufacturer's written certification stating that firestopping materials, meet or exceed the requirements specified under this Section and that all fire-resistive requirements for the indicated combustibility, Flame (F-rating) and Temperature (T-rating) Ratings have been met.
3. Manufacturer's installation instructions.
4. Test reports: Submit fire test reports from recognized, independent testing agent(s) indicating the following:
 - a. Fire test report of firestop material applied to substrate and penetration materials similar to project conditions. Tests to indicate both Flame (F-rating) and Temperature (T-rating) Ratings.
 - b. Test reports of products to be used shall indicate conformance to ASTM E-814.
5. On-site sample installation to be included in Work: Minimum thirty days prior to application in any area, provide samples of firestop and smoke seal materials and installation in accordance with the following requirements.
 - a. Apply one sample of appropriate firestop and smoke seal material for each different penetration and fire rating required for the work.
 - b. Sample areas will comply with thickness, fire resistance ratings, and finished appearance of the project and applicable fire code.
 - c. Acceptance samples will constitute standard of acceptance for method of application, thickness, and finished appearance for firestop and smoke seal application. The sample(s) shall remain visible during completion of the work and shall remain as part of the completed work.
6. Shop drawings indicating requirements for penetrations in wall/deck intersections, change of planes, control joints, expansion joints and blank openings.

1.6 QUALITY ASSURANCE

- A. General: Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
- B. Sole Source: Obtain firestop and smoke seal products from a single manufacturer, except as otherwise approved by Architect.
- C. Environmental Requirements for Volatile Chemicals: Use firestopping caulks that comply with the following limits for VOC content:
 1. Firestopping caulks: VOC not more than 250 g/L.
- D. Special Inspections: Allow for 3 percent of each type of firestopping system to be removed and inspected for conformance with approved submittals.

1. All firestopping shall be inspected prior to installation of suspended ceilings or concealed by other materials.

E. Qualifications:

1. Installer: a specialized subcontractor having not less than 3 years documented experience demonstrating previously successful work of the type specified herein.
 - a. The manufacturer of the firestop material shall submit written certification that the firm to be used for the firestop products has been trained in the application of the products by the manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store firestopping materials in original, sealed, packages showing manufacturer's identification and date of packaging.
- B. Store and handle materials following manufacturer's recommended procedures, and in accordance with material safety data sheets.

1.8 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering similar products include the following, or approved equal:
 1. Bio Fireshield (A Division of Rectroseal), Houston TX.
 2. Dow Corning Corporation, Midland MI.
 3. Hilti, Inc. Tulsa OK.
 4. 3M Company, Saint Paul MN.
 5. Specified Technologies, Inc., Somerville NJ.
 6. Metacaulk, (A Division of Rectroseal), Houston TX.
 7. Tremco, Inc., Beachwood OH.

2.2 REGULATORY REQUIREMENTS

- A. Conform to applicable code for fire resistance ratings and surface burning characteristics.
- B. Obtain certificate of compliance from authority having jurisdiction indicating approval of combustibility.

2.3 MATERIALS

- A. Firestop mortar: asbestos free, cementitious mortar, U.L. classified as a "fill, void, or cavity material" for through penetration firestop system when tested in accordance with ASTM/UL1479.
 - 1. Acceptable products, or approved equal:
 - a. Bio Fireshield, product "Novasit K-10".
 - b. Specified Technologies, Inc., product "Spec Seal Mortar".
 - c. Tremco Inc., product "Tremstop M".

- B. Silicone Firestop sealant: Single component, non-combustible silicone elastomer firestop sealant, U.L. classified as a "fill, void, or cavity material" for through penetration firestop system when tested in accordance with ASTM E-814/UL1479.
 - 1. Acceptable products, or approved equal:
 - a. Bio Fireshield, product product "Biotherm 100" (Gun Grade) or "Biotherm 200" (Self Leveling).
 - b. Specified Technologies, Inc., product "Spec Seal Pensil 300 Sealant (gun grade)" or "Spec Seal Pensil 300SL" (Self Leveling).
 - c. 3M Company, product "Fire Barrier Silicone Sealants".
 - d. Tremco Inc., product product "Tremsil" (Gun Grade) or "Tremsil S/L" (Self Leveling).
 - 2. Sealants will not dissolve in water.

- C. Intumescent firestop sealant and caulks: Acrylic based, water resistant sealant, which will not re-emulsify after drying.
 - 1. Acceptable products, or approved equal:
 - a. Bio Fireshield, product "Biostop 500".
 - b. Specified Technologies, Inc., product "Spec Seal Triple-S Sealant".
 - c. 3M Company, product "Fire Barrier Caulk CP25WB+".
 - d. Tremco Inc., product "Tremstop 1A".

- D. Firestop putty: sticks or pads.
 - 1. Acceptable products, or approved equal:
 - a. Bio Fireshield, product "Moldable Putty".
 - b. Specified Technologies, Inc., product "Spec Seal Putty Bars and Pads".
 - c. 3M Company, product "Fire Barrier Moldable Putty".
 - d. Tremco Inc., product "Flowable Putty".

- E. Firestop collars: Pre-manufactured fire protective pipe sleeve, UL classified as "fill, void, or cavity material" for through penetration firestop system when tested in accordance with ASTM E-814/UL1479.
 - 1. Provide separated (two piece) firestop collar for application when plastic pipe system is already in place. Provide non-separated firestop collar for application prior to installation of plastic pipe system.

2. Acceptable products, or approved equal:
 - a. 3M Company, Inc., product "Fireshield Firestop Sleeve".
 - b. Specified Technologies, Inc., product "Spec Seal Collars".
 - c. 3M Company, product "Fire Barrier PPD's".
 - d. Tremco Inc., product "Fyrecan sleeve".

- F. Firestop pillows: UL Classified as "fill, void, or cavity material" for through penetration firestop system when tested in accordance with ASTM E-814/UL1479.
 1. Acceptable products, or approved equal:
 - a. Bio Fireshield, product "Fireshield Firestop Pillows".
 - b. Specified Technologies, Inc., product "Spec Seal Pillows".
 - c. Tremco Inc., product "Tremstop P.S".

- G. Wrap strips:
 1. Acceptable products, or approved equal:
 - a. Bio Fireshield, product "FS-195".
 - b. Specified Technologies, Inc., product "Spec Seal Wrap Strip".
 - c. 3M Company, product "Fire Barrier FS195 Wrap Strip".
 - d. Tremco Inc., product "Tremco W.S".

- H. Mineral wool fiber / ceramic wool non-combustible insulation (fire safing): Conforming to ASTM C665, Type 1, ASTM C612, and ASTM C553 with a minimum density of 4 pounds per cubic foot.
 1. Flame Spread Classification: Material shall be classified non-combustible per ASTM E-814.
 2. Recycled content of slag:: Use maximum available percentage of material (slag). Mineral wool insulation products incorporated into the work shall contain not less than 75 percent of recycled material (slag) by weight.
 3. Acceptable products include:
 - a. Fibrex Insulations Inc. Sarnia Ontario, Canada, product: "Fibrex FBX" Industrial board.
 - b. Rock Wool Manufacturing Company, Leeds, AL, product: "Delta Safing Mineral Wool".
 - c. Roxul, Inc., product "Roxul Safe".
 - d. Thermafiber, Inc. product "Safing 4.0 pcf".
 4. Accessories: Provide galvanized steel safing clips as required for installation of insulation.

- I. Elastomeric Firestopping: Non halogenated latex based elastomeric coating applied by airless spray.
 1. Acceptable products, or approved equal:
 - a. Specified Technologies, Inc., product "Spec Seal Elastomeric Firestop

Spray”.

- b. Bio Fireshield (A Division of Rectroseal), product “Flamesafe FS900+”
- c. Hilti, Inc., product “CP 601S.”

2.4 ACCESSORIES

- A. Forming and damming materials: Mineral fiberboard or other type as recommended by firestopping manufacturer.
- B. Primer, sealant and solvents: As recommended by manufacturer.
- C. Woven wire mesh: Galvanized 20 gage woven wire mesh “chicken wire” or “poultry fencing”, 1 inch spacing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Inspect areas and conditions where firestops are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
 - 1. Beginning of installation means acceptance of existing substrate and project conditions.

3.2 PREPARATION

- A. Surface to receive firestops shall be free of dirt, dust, grease, oil, form release agents, or other matter that would impair the bond of the firestop material to the substrate or penetrating item(s).
- B. Voids and cracks in substrate shall be filled and unnecessary projection removed prior to installation of firestops.
- C. All penetrating items shall be permanently installed prior to firestop installation.
- D. Substrate shall be frost, free and, when applicable, dry.

3.3 INSTALLATION

- A. General
 - 1. Installation of firestops shall be performed by applicators/installers qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
 - 2. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations. Meet building code requirements.
 - 3. Coordinate with plumbing, mechanical, electrical, and other trades to assure that

all pipe, conduit, cable, and other items which penetrate fire rated construction have been permanently installed prior to installation of firestops. Schedule and sequence the work to assure that partitions and other

construction which would conceal penetrations are not erected prior to the installation of firestops.

- a. Ensure that all firestopping is inspected prior to installation of suspended ceilings or concealed by other finished materials.

B. Dam construction

1. Install dams when required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Combustible damming material must be removed after appropriate curing. Incombustible damming material may be left as a permanent component of the firestop system.
2. Placement of dams shall not interfere with function or adversely affect the appearance of adjacent construction.

C. Installation of single component silicone firestop

1. Apply with manual or powered caulking gun.
2. Apply minimum 1/2 inch thickness for 2 hour rating. Apply 1/2 inch to both sides of wall penetrations; one side only in floor penetrations.
3. Use incombustible insulation as required to achieve fire resistance rating.
4. Surface of gun grade silicone firestop may be tooled using clean, potable water.
5. Clean excess material off of adjacent surfaces and tools within 10 minutes using either water or Xylol where the use of such would not be hazardous.

D. Installation of cementitious firestop mortar.

1. Add dry powder to water and mix with mechanical mixer or hand mixing tools as recommended by firestop mortar manufacturer. Allow a average mixing time is 3 minutes and provide a average wet density of 70 pounds per cubic foot, plus or minus 5 PCF.
2. Do not apply if ambient or substrate temperature is less than 35 degrees Fahrenheit during 24 hours after application.
3. Wet all surfaces prior to application of firestop mortar.
4. Mortar may be hand applied or pumped into the opening.
5. Exposed surfaces shall be finished using conventional plastering tools prior to curing.
6. When installation around layered cables, it is recommended to increase the fluidity of the firestop mortar to provide a better fill around the cables. Vibrate or move the cables slightly to prevent voids from forming between the cables.
7. Allow 48 hours for initial cure prior to form removal. For full cure allow 27 days.
8. Wet material may be cleaned with water. Dry material may require scraping or

chipping.

- E. Installation of firestop collars (plastic pipe only)
 - 1. Firestop collars may be surface mounted to a slab or wall or imbedded in Firestop Mortar to a maximum depth of 2 inches.
 - 2. For wall penetrations with ABS pipe firestop collars must be installed on both sides of the penetration to provide a 2 hour F and T Rating. All other applications required installation on one side only to provide a 2 hour F and T Rating.
- F. Firesafing insulation: Install firestopping safing insulation on safing clips spaced as needed between each stud and floor slab, leaving no voids. Secure safing clips to slab using fasteners recommended by insulation manufacturer. Install sealant over mineral wool in accordance with test requirements.
- G. Conclusion of work day: Wherever work is performed in areas which abut or are adjacent to Owner occupied areas, at the conclusion of the work day ensure that all penetrations and perimeter construction joints are firestopped and that there are no openings, penetrations or construction joints left unprotected.

3.4 LABELING

- A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems.
 - 1. Include the following information on labels

**WARNING: THROUGH-PENETRATION FIRESTOP SYSTEM-DO NOT DISTURB.
NOTIFY FACILITY MANAGER OF ANY DAMAGE.**

- Contractor's name, address, and phone number.
- Through-penetration firestop systems designation of applicable testing and inspecting agency.
- Date of installation.
- Through-penetration firestop systems manufacturer's name.
- Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.
 - 1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.
- B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.

- C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.6 SCHEDULE

- A. General: Typical penetrations are indicated below with list of standard firestopping/smokeseal approaches. Actual firestopping materials and combination of materials will vary with size of penetration and with individual firestopping manufacturer's approved UL Design System Requirements. Use only UL Design System materials for each penetration that best matches the wall and floor construction.
 - 1. Where penetrations occur for which no listed UL or WH Design System test exists, obtain from the firestop system manufacturer an engineered system acceptable to the authorities having jurisdiction for firestopping such penetrations. Engineered system from manufacturer shall include a detail drawing showing the engineered system and shall contain no disclaimers.
- B. Single metal pipe (non-insulated) and conduit penetrations through floors:
 - 1. Firestop mortar.
 - 2. Silicone Firestop sealant.
 - 3. Intumescent firestop sealant.
 - 4. Firestop putty, sticks or pads.
 - 5. Mineral fiber / ceramic wool non-combustible insulation (fire safing) in conjunction with a firestop sealant.
- C. Single metal pipe (non-insulated) and conduit penetrations through walls:
 - 1. (masonry and concrete walls only) Firestop mortar and putty.
 - 2. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 - 3. Intumescent firestop sealant with wrap strips.
- D. Multiple metal pipe and conduit penetrations through floors:
 - 1. Firestop mortar and wrap strips.
 - 2. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
- E. Multiple metal pipe and conduit penetrations through walls:
 - 1. Firestop mortar and putty.
 - 2. (through masonry walls only) Firestop pillows with woven wire mesh.
 - 3. Silicone Firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
- F. Insulated metal pipe penetrations through floors:
 - 1. Firestop mortar and wrap strips.
 - 2. Silicone Firestop sealant over mineral fiber / ceramic wool non-combustible

- insulation (fire safing).
3. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 4. Silicone Firestop sealant over wrap strip.
 5. Mineral fiber / ceramic wool non-combustible insulation (fire safing) in conjunction with a firestop sealant.
- G. Insulated metal pipe penetrations (single and multiple) through walls:
1. Firestop mortar with wrap strips.
 2. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 3. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing) and Wrap strips.
 4. (multiple penetrations through masonry walls only) Firestop pillows with woven wire mesh.
- H. Duct penetrations through floors or walls:
1. Rectangular and square ducts: Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing), and steel flanges provided under Division 15.
 2. Round ducts: Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
- I. Combustible plastic pipe and conduit penetrations through floors:
1. Firestop mortar with wrap strips.
 2. Firestop mortar with firestop putty and firestop collars.
 3. Silicone firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 4. Silicone firestop sealant and firestop collars.
 5. Intumescent firestop sealant and firestop collars.
 6. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing) with firestop collars.
 7. (maximum pipe size 2 inches) Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing) with wrap strips.
- J. Combustible plastic pipe and conduit penetrations through walls:
1. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 2. Intumescent firestop sealant with firestop collars.
- K. Cable penetrations through floors:
1. Silicone Firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 2. Intumescent firestop sealant over mineral fiber / ceramic wool non-

combustible insulation (fire safing).

- L. Cable penetrations through walls:
 - 1. Silicone Firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 - 2. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 - 3. (single penetrations only) Firestop putty.
 - 4. (electrical boxes) Firestop pads.
 - 5. Firestop putty over mineral fiber / ceramic wool non-combustible insulation (fire safing).
- M. Bus ducts through floors:
 - 1. Firestop mortar and wrap strips.
 - 2. Intumescent firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing) and 28 gage (minimum) steel cover plate.
- N. Blank openings:
 - 1. Firestop mortar.
 - 2. Silicone Firestop sealant over mineral fiber / ceramic wool non-combustible insulation (fire safing).
- O. Fire rated joints:
 - 1. Silicone Firestop sealant over backer rod or bond breaker.
- P. Construction joints at head of wall/floor assemblies:
 - 1. Silicone Firestop sealant/mastic over mineral fiber / ceramic wool non-combustible insulation (fire safing).
 - 2. Elastomeric spray over mineral fiber / ceramic wool non-combustible insulation (fire safing).
- Q. Smoke barrier sealant for dampers, fire door frames:
 - 1. Silicone Firestop sealant.
- R. Temporary sealing of openings and penetrations:
 - 1. Firestop putty, sticks or pads.
 - 2. Firestop pillows.

End of Section 07 84 13

SECTION 07 92 00 JOINT SEALANTS**PART 1 - GENERAL**

1.1 SUMMARY

- A. General: The work of this Section consists of sealants and backing materials where shown on the Drawings, as specified herein, and as required for a complete and proper installation.
 - 1. This Section specifies general requirements, definition of joint sealer types, and application requirements for sealant work specified within other individual specification sections.
- B. Prepare sealant substrate surfaces.
- C. Furnish and install sealant and backing materials.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 07 84 00 - FIRESTOPPING: Firestopping sealants and related backing materials.
- D. Section 08 80 00 - GLAZING: Sealant used in conjunction with setting glass.
- E. Section 09 21 10 - GYPSUM BOARD ASSEMBLIES: Application of concealed acoustical sealant used in conjunction with gypsum board work at abutting surfaces (perimeter of partitions and walls).
- F. Section 09 91 00 - PAINTING: Caulks used in preparation of applied finish coatings.

1.3 REFERENCES

- A. The standards referenced herein are included to establish recognized quality only. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.
- B. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. ASTM C 717 - Standard Terminology of Building Seals and Sealants.
 - 2. ASTM C 790 – Guide for Use of Latex Sealants
 - 3. ASTM C 804 - Use of Solvent-Release Type Sealants.

4. ASTM C 834 - Latex Sealing Compounds.
 5. ASTM C 919 - Use of Sealants in Acoustical Applications.
 6. ASTM C 920 - Elastomeric Joint Sealants.
 7. ASTM C 962 - Use of Elastomeric Joint Sealants.
 8. ASTM C 1193 - Guide for Use of Joint Sealants.
 9. ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
 10. ASTM D 3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
 11. FS TT-S-001543A - Sealing Compound, Silicone Rubber Base.
- C. The following reference materials are hereby made a part of this Section by reference thereto:
1. SWRI – Sealant and Caulking Guide Specification.

1.4 SUBMITTALS

- A. Information and Review Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
1. Product Data: Manufacturer's product data sheets, specifications, performance data, chemical and physical properties and installation instructions for each item furnished hereunder.
 2. Selection Samples: Sample card indicating Manufacturer's full range of colors available for selection by Architect.
 3. Verification Samples: 12 inch long samples of sealant for verification of color, installed where directed by Architect.
 4. Certificates: Manufacturer's certification that the Products supplied meet or exceed specified requirements.
 5. Test and Evaluation Reports:
 - a. Compatibility and adhesion test reports: Test reports from sealant manufacturer indicating that sealant proposed for use have been tested for compatibility and adhesion with actual samples of substrates to be used on this project. Include sealant manufacturer's interpretation of test results, and recommendations for primers and substrate preparation specific to this Project.
- B. Closeout Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS.
1. Bonds and Warranty Documentation: Manufacturer's standard Warranties and Guarantees.

1.5 QUALITY ASSURANCE

- A. General: Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
- B. Sole Source: Provide sealants from a single manufacturer for all work of this Section to the greatest extent possible. Each individual type of sealant installed in the Work

shall be from a single manufacturer.

- C. Qualifications:
1. Testing Agencies: To qualify for acceptance, an independent testing laboratory must demonstrate to Architect's satisfaction that it has the experience and capability to conduct satisfactory testing indicated without delaying progress of the Work.
- D. Preconstruction Compatibility and Adhesion Testing: Submit samples of all materials that will contact or affect joint sealers to joint sealer manufacturers for compatibility and adhesion testing, as indicated below:
1. Use test methods standard with manufacturer to determine if priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealers to joint substrates.
 - a. Perform tests under normal environmental conditions that will exist during actual installation.
 2. Contractor shall submit for testing, and sealant manufacturer shall test at least 9 pieces of each type of material, including joint substrates, shims, and joint backer rods.
 3. Schedule testing so that it does not delay the work.
 4. Investigate materials failing these tests and obtain joint sealer manufacturer's written recommendations for corrective measures, including use of specially formulated primers.
 5. The Architect may waive part or all of these specific testing requirements if the sealant manufacturer is able to provide written certification, demonstration to the Architect's satisfaction, that sealant and substrates are compatible and that sealant performance and adhesion will not be compromised by project conditions.
- E. Product Testing: Provide comprehensive test data for each type of joint sealer based on tests conducted by a qualified independent testing laboratory on current product formulations within 24-month period preceding date of Contractor's submittal of test results to Architect.
1. Test elastomeric sealant for compliance with requirements specified by reference to ASTM C920. Include test results for hardness, stain resistance, adhesion and cohesion under cyclic movement (per ASTM C719), low-temperature flexibility, modulus of elasticity at 100% strain, effects of heat aging, and effects of accelerated weathering.
 2. Include test results performed on joint sealers after they have cured 1 year.
- F. Preconstruction Field Testing: Prior to installation of joint sealants, field-test their adhesion to joint substrates as follows:
1. Locate test joints where indicated or, if not indicated, as directed by Architect.
 2. Conduct field test for each type of elastomeric sealant and joint substrate indicated.
 3. Arrange for tests to take place with both Architect and joint sealer manufacturer's technical representative present.
 4. Test Method: Test joint sealers by hand pull method described below:

- a. Install joint sealant in 5-foot joint lengths using same materials and methods for joint preparation and joint sealant installation required for completed Work. Allow sealant to cure fully before testing.
 - b. Make knife cuts as follows: A horizontal cut from one side of joint to the other followed by 2 vertical cuts approximately 2 inches long at side of joint and meeting horizontal cut at top of 2 inch cuts. Place a mark 1 in. from top of 2 inch piece.
 - c. Use fingers to grasp 2 inch piece of sealant above 1 in. mark; pull firmly down at 90 degree angle or more while holding a straightedge along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.
5. Evaluation of field test results:
- a. For sealant evidencing adhesive failure, determine if primer is required. If so, re-test using primer.
 - b. Sealant not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory.
 - c. Do not use sealant which fails to adhere to joint substrates during testing.
6. Submit report to Architect with description of test, results, and recommended installation procedures to obtain proper adhesion.
- a. Report whether or not sealant in joint connected to pull-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Each container and package must bear an unbroken seal, test number and label of the manufacturer upon delivery to the site. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by the Architect and his requiring its removal from the site. New material conforming to said requirements, shall be promptly furnished at no additional cost to the Contract.

1.7 SITE CONDITIONS

- A. Do not install single component solvent curing sealant in enclosed building spaces.
- B. Environmental Requirements: Maintain temperature and humidity recommended by the sealant manufacturer during and 24 hours after installation. Do not proceed with installation of joint sealers under the following conditions:
 1. When ambient and substrate temperature conditions are below 40 degrees F.
 2. When joint substrates are wet due to rain, frost, condensation, or other causes.
- C. Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from substrates.

1.8 WARRANTY

- A. Provide 5 year warranty under provisions of Division 01 –GENERAL REQUIREMENTS. Warranty shall include coverage of installed sealant and accessories which fail to achieve air tight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specified Manufacturers and Products: To establish a standard of quality, design and function desired, Drawings and specifications have been based on the products specified under this section for each individual sealant type, for the applications scheduled at the end of Section, and as may be additionally identified on the Drawings.
- B. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 - 1. Pecora Corporation, Harleysville PA.
 - 2. Sika Corp, Lyndhurst NJ.
 - 3. Sonneborn Building Products Inc., Minneapolis MN.
 - 4. Tremco, Inc., Beachwood OH.

2.2 SEALANT MATERIALS

- A. Sealant Materials, General Requirements:
 - 1. Only use sealant and primers that comply with the following limits for VOC content:
 - a. Architectural Sealants: 250 g/L.
 - b. Roofing Sealants: 450 g/L.
 - c. Roadway Sealants: 250 g/L.
 - d. Sealant primer: 250 g/L.
 - 2. Sealants containing PCB's, aromatic solvents, fibrous talc, formaldehyde, halogenated solvents, mercury, lead, cadmium, chromium and their compounds or asbestos are not permitted.
- B. Joint Sealer Type AA (Acrylic acoustical): One component acrylic latex, permanently elastic, non-staining, non-shrinking, non-migrating and paintable.
 - 1. Tremco, product "Acoustical Sealant".
 - 2. USG, product "USG Acoustical Sealant".
 - 3. Pecora, product " AC-20 FTR".
- C. Joint Sealer Type AP (Acrylic painters caulk): One component acrylic latex caulking compound, conforming to FS 19-TP-21M and ASTM C 834, paintable within 24 hours after application, with a minimum movement capability of ± 12.5 percent, equal to one

of the following:

1. Sonneborn, product, "Sonolac".
 2. Tremco, product, "Tremflex 834".
 3. Bostik, product, "Chem-Calk 600".
 4. Pecora, product " AC-20+".
- D. Joint Sealer Type HL2 (Horizontal-self-Leveling, 2-component): Pouring grade self-leveling multi-component urethane sealant, conforming to FS TT-S-000227E, Type I, Class A, and ASTM C 920, with a minimum movement capability of ± 25 percent, equal to the following:
1. Sika, product, "Sikaflex 2CSL".
 2. Sonneborn, product, "SL2".
 3. Tremco, product, "THC-900 / THC-901".
- E. Joint Sealer Type HT (Horizontal-Trowel): Trowel grade multi-component modified-urethane or neutral-cure silicone paste sealant, conforming to FS TT-S-000227E, Type I, Class A, and ASTM C 920, with a minimum movement capability of ± 25 percent, equal to the following:
1. GE silicones, product "Tosseal 811" (silicone).
 2. Pecora, product "Dynatred" (urethane).
 3. Sika, product "Sikaflex 2CTG" (urethane).
 4. Sonneborn, product "SL2 (slope grade)" (urethane).
 5. Tremco, product "THC-901" (urethane).
- F. Joint Sealer Type SC (Silicone, general construction): One-part medium modulus, natural cure, synthetic sealant, having a useful life expectancy of at least 20 years, conforming to ASTM C 920, Type S, NS, Class 25, use NT, G, A, M, O with a minimum movement capability of ± 50 percent, equal to the following:
1. Dow Corning, product, "791".
 2. GE Silicones, product, "Silpruf".
 3. Pecora, product, "895".
 4. Sika, product, "Sika Sil-C 995".
 5. Sonneborn, product, "Sonolastic - OmniSeal".
 6. Tremco, product, "Spectrem 2".
- G. Joint Sealer Type SE (Silicone, Exterior construction): One-part low modulus, moisture curing, synthetic rubber sealant, having a useful life expectancy of at least 20 years, conforming to ASTM C 920, Type S, NS, Class 25, FS TT-S-001543A, Type, Class A with a minimum movement capability of +100 percent and -50 percent, equal to the following:
1. Dow Corning, product, "790".
 2. GE Silicones, product, "SCS9000 SilPruf NB".
 3. Sika, product "Sika Sil-C 990".
 4. Tremco, product "Spectrem 1".

- H. Joint Sealer Type SF (Silicone, Food contact): one component silicone rubber, acceptable to local health officials, conforming to U.S. Food and Drug Administration regulation 21 CFR 175.105 and 175.300, FS TT-S-001543A, Type Non-Sag, Class A, and ASTM C 920, Type NS, Class 25, Use NT, G, O and A with a minimum movement capability of ± 25 percent, and a Shore A minimum hardness of 20, equal to the following:
1. Dow Corning, product, "732".
 2. GE Silicones, product "Series SCS1000".
- I. Joint Sealer Type SM (Silicone, Mildew-resistant): USDA approved one component acetoxysilicone rubber, mildew resistant, acceptable to local health officials, conforming to U.S. Food and Drug Administration regulation 21 CFR 177.2600, FS TT-S-001543A, Type Non-Sag, Class A, and FS TT-S-00230C, Type II, Class A and ASTM C 920, Type S, Class 25, Grade NS, use NT,G and A with a minimum movement capability of ± 25 percent, and a Shore A hardness of 20, equal to the following:
1. Dow Corning, product "786".
 2. GE Silicones, product "Sanitary 1700".
 3. Sonneborn, product "Sonolastic - OmniPlus".
 4. Tremco, product "Tremsil 200".
 5. Pecora, product "898".
- J. Joint Sealer Type SX (Silicone, Exterior construction): One-part low modulus, neutral curing, low to no bleed silicone, having a useful life expectancy of at least 20 years, conforming to ASTM C 920, Type S, NS, Class 50, FS TT-S-00230C, Type II, Class A with a minimum movement capability of +50 percent and -50 percent, equal to the following:
1. Dow Corning, product, "790".
 2. GE Silicones, product, "SCS2700 SilPruf LM".
 3. Sika, product "Sikasil-WS-290".
 4. Tremco, product "Spectrem 4TS".

2.3 ACCESSORIES

- A. Compressible joint bead back-up: Compressible closed cell polyethylene, extruded polyolefin or polyurethane foam rod complying with ASTM C 1330, Type C, 1/3 greater in diameter than width of joint. Shape and size of compressible back-up shall be as recommended by manufacturer for the specific condition used. Provide one of the following, or equal.
1. Nomaco, Inc., Zebulon, NC, product "Green Rod".
 2. Industrial Thermo Polymers Ltd., Brampton, Ontario CN, product "ITP Standard Backer Rod".
 3. BASF Sonneborn Building Products Inc., Minneapolis MN, product "Sonolastic Closed Cell Backer Rod".
 4. W.R. Meadows Inc., Hampshire, IL, product "Sealtight Kool-Rod".
- B. Primers: Furnish and install joint primers of the types, and to the extent, recommended by the respective sealant manufacturers for the specific joint

materials and joint function.

- C. Bond-breaker tape, and temporary masking tape: Of types as recommended by the manufacturer of the specific sealant and caulking material used at each application, and completely free from contaminants which would adversely affect the sealant and caulking materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General:
 - 1. Weather conditions must be dry and of the temperature, as recommended by sealant manufacturer, during application operations.
 - 2. Surface receiving work of this section must be absolutely dry and dust free. All joints receiving sealant/caulking materials and primers shall be subject to the approval of the sealant manufacturer for proper use of specified materials.
- B. Thoroughly clean all joints, removing all loose mortar, oil, grease, dust, frost, and other foreign materials that will prevent proper adhesion of primers and sealant materials.
 - 1. Clean ferrous metals of all rust and coatings by wire brush, grinding or sandblasting. Remove oil, grease and protective coatings with cleaners recommended by sealant manufacturer.
- C. Prime joint substrates, as recommended in writing by joint-sealant manufacturer, as based on preconstruction joint-sealant-substrate tests or as based upon prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- D. Verify that joint backing and release tapes are compatible with sealant.
- E. Perform preparation in accordance with ASTM C 804 and C 790 for solvent and latex base solvents, respectively.

3.3 INSTALLATION

- A. General: Conform to SWRI requirements, and sealant manufacturer's written requirements for installation.
- B. Install joint bead back-up in all joints in excess of 5/8-inch depth, and joints that have no back-up therein, placing the joint bead in the joint in a manner that will assure a

constant depth 1/8 inch greater than the sealant and caulking material depth tolerances.

1. Set beads into joints continuously, by slightly stretching during placement, to permit compression against sides of joint, without surface wrinkles or buckles.
 2. Do not stretch back-up material into joints.
- C. Install bond breaker in joints where shown in the Drawings and wherever recommended by the sealant manufacturer to prevent bond of the sealant to surfaces where such bond might impair the Work.
- D. Apply masking tape or other precautions to prevent migration or spillage of materials onto adjoining surfaces.
- E. Apply urethane sealant and latex caulking materials into joints in accordance with manufacturer's instructions, using mechanical or power caulking gun equipped with nozzle of appropriate size, with sufficient pressure to completely fill the joints.
1. The depth of sealant and caulking materials shall be in accordance with manufacturer's recommendations for the specific joint function, but in no case exceed 1/2-inch in depth, nor less than 1/4-inch, regardless of the joint width.
 2. Maintain the outer edge of the sealant and caulking materials, where side faces of joints are in the same plane, back 1/8-inch from the faces.
 3. Apply sealant in continuous beads without open joints, voids or air pockets so as to provide a watertight and airtight seal for the entire joint length.
 4. After placement of the sealant and caulking materials, concave-tool the surfaces to uniform density, using a water-wet tool. Do not use detergents or soapy water for the tooling operations.
 5. Remove the temporary masking tape immediately after tooling, and before the sealant or caulking material has taken initial set.
- F. Take care not to block-off weep tubes or any through wall opening constructed to allow weeping of accumulated water.
- G. Apply pouring self-leveling urethane sealant (Sealant designation HL) into horizontal joints in accordance with manufacturer's instructions, to a level approximately 1/16 inch below adjacent surfaces.
1. Apply sealant without open joints, voids or air pockets so as to provide a watertight and airtight seal for the entire joint length.
 2. After placement of the sealant and caulking materials, concave-tool the surfaces to uniform density, using a water-wet tool. Do not use detergents or soapy water for the tooling operations.
 3. Remove the temporary masking tape immediately after tooling, and before the sealant has taken initial set.

3.4 CLEANING

- A. Clean all surfaces of adjacent surfaces which have been marked or soiled by the work of this Section, removing all excess sealant and caulking materials with solvents which will not damage the surfaces in any way.

3.5 PROTECTION

- A. During the operation of sealant work, protect the work of other trades against undue soilage and damage by the exercise of reasonable care and precautions. Repair or replace any work so damaged and soiled.

3.6 SCHEDULE

- A. General: Seal joints indicated and all interior and exterior joints, seams, and intersections between dissimilar materials.

- B. Sealant Colors:
 - 1. Colors for Sealant Types "HL2": Match colors furnished by the Architect, or match other building materials as directed. Should such custom colors not be available from the approved manufacturer, except at additional charge, provide all such colors at no change in Contract Sum.
 - 2. Colors for Sealant Types "BP2", "HT", "SC", "SE", and "SM": As selected by the Architect from manufacturer's standard colors.
 - 3. Color for Sealant Types "AA" and "AP": White.
 - 4. In concealed installation, and in partially or fully exposed installation where so approved by the Architect, standard gray or black sealant may be used.
- C. Specialty Joint Conditions:

3.7 SCHEDULE

- A. General: Seal joints indicated and all interior and exterior joints, seams, and intersections between dissimilar materials.
- B. Sealant Colors:
 - 1. Colors for Sealant Types "HL2": Match colors furnished by the Architect, or match other building materials as directed. Should such custom colors not be available from the approved manufacturer, except at additional charge, provide all such colors at no change in Contract Sum.
 - 2. Colors for Sealant Types "HT", "SC", "SE", "SM" and "SX": As selected by the Architect from manufacturer's standard colors.
 - 3. Color for Sealant Types "AA" and "AP": White.
 - 4. In concealed installation, and in partially or fully exposed installation where so approved by the Architect, standard gray or black sealant may be used.
- C. Specialty Joint Conditions:
- D. Exterior joints (Listed by primary building material abutting sealant joints):

1. Concrete:		
	Joint Condition	Sealant Type
a.	Concrete to concrete, vertical control joints:	SE
b.	Concrete foundation walls to abutting concrete, and other non-bituminous pavements, steps, platforms, and ends of ramp, (horizontal joints):	HL2
c.	Concrete slabs on grade to abutting non-bituminous pavements (horizontal joints, including pedestrian traffic surfaces):	HL2
d.	Concrete to concrete saw cut and tooled control and isolation joints in horizontal surfaces including pedestrian traffic surfaces:	HL2
e.	Concrete and non-bituminous sloped (5% to 12%)	HT

pavement ramps (horizontal joint) at abutting concrete or masonry foundation walls:

- f. Concrete to all items which penetrate exterior concrete walls, including, but not necessarily limited to, door frames, louver frames, pipes, vents, and similar items: SE

2. Exterior Masonry:

Joint Condition	Sealant Type
a. Masonry to masonry, expansion and control joints:	SE
b. Masonry to abutting masonry or concrete:	SE
c. Masonry to abutting non-porous materials (painted metals, anodized aluminum, mill finished aluminum, PVC, glass, and similar materials):	
d. Masonry to all items which penetrate exterior masonry walls, including, but not necessarily limited to, door frames, louver frames, pipes, vents, and similar items:	

3. Exterior Metal:SE or SX SE

Joint Condition	Sealant Type
a. Metal to metal:	SX
b. Metal to glass:	SX

E. Interior joints (Listed by primary building material abutting sealant joints):

1. Interior Concrete:

Joint Condition	Sealant Type
a. Concrete to concrete, vertical joints:	SC
b. Concrete to concrete: horizontal walkable surfaces:	HL2
c. Concrete and non-bituminous pavement ramps (5 to 12 Percent) horizontal joints at abutting vertical concrete or masonry surfaces:	HT
d. Concrete to all items which penetrate concrete walls, including, but not necessarily limited to, door frames, louver frames, pipes, vents, and similar items:	SC
e. Precast concrete to abutting materials (vertical joints):	SC

2. Interior Masonry:

* Includes interior side of exterior masonry walls.

Joint Condition	Sealant Type
a. Masonry to masonry control joints*:	SC
b. Masonry* to gypsum board:	SC
c. Masonry to all items which penetrate masonry walls, including, but not necessarily limited to, window frames, door frames, louver frames, and similar items:	SC
d. Masonry to all pipes, conduit and vents which penetrate non-rated masonry walls*:	SC

3. Gypsum Board:

Joint Condition	Sealant Type
a. Gypsum board to metal or wood trim:	AP
b. Gypsum board to abutting surfaces at exposed tops and bottoms partitions and walls:	AA
c. Gypsum board to masonry:	SC
d. Gypsum board to interior door and window frames, penetrating conduits and piping, light-fixtures, electrical cover plates, building specialty items, ductwork, grilles, supply diffusers, faucets, piping, escutcheon plates and similar items:	AP
e. Gypsum board to plumbing fixtures:	SM

4. Architectural millwork and casework:

Joint Condition	Sealant Type
a. Casework to abutting materials, kitchens, toilet rooms and similar "wet spaces":	SM
b. Casework to abutting surfaces (except in "wet" spaces):	AP
c. Countertops to abutting wall surfaces and to abutting casework:	SM
d. Countertops to plumbing fixtures and fittings:	SM

5. Interior metal:

Joint Condition	Sealant Type
a. Metal to metal:	SC

6. Interior floor drains:

Joint Condition	Sealant Type
a. Floor drains to concrete slab:	SE
b. Floor drains to resilient sheet flooring:	SE

7. Acoustical ceilings:

Joint Condition	Sealant Type
a. Acoustical ceiling edge angle to irregular wall surface	AP

8. Tile:

Joint Condition	Sealant Type
a. Tile to tile vertical, and horizontal non-traffic joints:	SM
b. Tile to tile, horizontal pedestrian traffic joints:	HL2

9. Interior Wood:

Joint Condition	Sealant Type
a. Wood to wood (natural or stained finishes)	SC
b. Wood to wood (painted opaque finishes)	AP
c. Wood to metal	SC

- d. Wood base to wall surfaces

SC

End of Section 07 92 00

080671 DOOR HARDWARE SCHEDULE**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section references specification sections relating to commercial door hardware for the following:
1. Swinging doors.
 2. Sliding Doors.
 3. Other doors to the extent indicated.
- B. Commercial door hardware includes, but is not necessarily limited to, the following:
1. Mechanical door hardware.
 2. Electromechanical and access control door hardware.
 3. Electromechanical and access control door hardware power supplies, back-ups and surge protection.
 4. Cylinders specified for doors in other sections.
 5. Division 26 Sections "Electrical".
 6. Division 28 Section "Access Control".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 2. ICC/IBC - International Building Code.
 3. NFPA 70 - National Electrical Code.
 4. NFPA 80 - Fire Doors and Windows.
 5. NFPA 101 - Life Safety Code.
 6. NFPA 105 - Installation of Smoke Door Assemblies.
 7. State Building Codes, Local Amendments.
- E. Standards: Reference Related Sections for requirements regarding compliance with applicable industry standards.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 - 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.
- D. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division

01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.

- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in the Related Sections.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum [5] years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum [3] years documented experience installing both standard and electrified builders hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum [5] years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor in good standing by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- D. Source Limitations: Obtain each type and variety of Door Hardware specified in the Related Sections from a single source, qualified supplier unless otherwise indicated.
- E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the applicable model building code.
- F. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Refer to "PART 3 - EXECUTION" for required specification sections.

PART 3 - EXECUTION

3.1 DOOR HARDWARE SETS

- A. The door hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
- B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.
- C. Products listed in the hardware sets shall be supplied by and in accordance with the requirements described in the specification section as noted for each item.
1. Section 08 71 00 – Door Hardware.
 2. .
- D. Manufacturer's Abbreviations:
1. MK - McKinney
 2. PE - Pemko
 3. RO - Rockwood
 4. SA - SARGENT
 5. MC - Medeco
 6. GS - ASSA ABLOY Glass Solutions
 7. RF - Rixson
 8. NO - Norton
 9. HG - HID Global

10. YA - Yale

11. SU - Securitron

E. DOOR HARDWARE SETS

1. Refer to Drawing A9.00

END OF SECTION 08 06 71

SECTION 08 11 10 HOLLOW METAL FRAMES**PART 1 – GENERAL**

1.1 SUMMARY

- A. Furnish the following products to be installed under the designated Sections:
 - 1. Hollow metal frames for doors, UL-Labeled and non-labeled, complete with internal reinforcing; installed under Section 06 10 00 - ROUGH CARPENTRY.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 06 10 00 - ROUGH CARPENTRY:
 - 1. Wood blocking, and nailers.
 - 2. Installation of hollow metal door frames.
 - 3. Placement and temporary bracing of hollow metal frames built-into masonry.
- D. Section 07 92 00 - JOINT SEALANTS.
- E. Section 09 91 00 - PAINTING: Applied finish coatings.
- F. Division 26 – ELECTRICAL: Wiring connections for electrified door hardware.
- G. Building-in of frame anchors to wall and partition construction: By trade responsible for wall and partition erection.

1.3 REFERENCES

- A. Reference Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. ANSI A 117.1 - Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
 - 2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical

Endurance for Steel Doors, Frames, Frame Anchors and Hardware Reinforcing.

3. ANSI/SDI A250.8 – R2008 (formerly SDI 100) - Recommended Specifications for Standard Steel Doors and Frames.
4. ANSI/SDI A250.11 – Recommended Erection Instructions for Steel Frames.
5. ASTM A109 / A109M - Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled.
6. ASTM A568 / A568M - Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.
7. ASTM A653 / A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 / A924M - General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
9. ASTM A1008 / A1008M - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
10. ASTM A1011 / A1011M - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
11. ASTM C1363 - Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
12. SDI 111 Series (111A-111F): Recommended Details, Steel Doors and Frames.
13. SDI 117-93: Manufacturing Tolerances for Standard Steel Doors and Frames.
14. NFPA publication 80 - Fire Doors and Windows.
15. NFPA publication 105 – Standard for the Installation of Smoke Door Assemblies.
16. UL publication 10B - Fire Tests of Door Assemblies.
17. UL publication 10C – Positive Pressure Fire Tests of Door Assemblies.
18. UL 1784 – Air Leakage Tests of Door Assemblies.
19. All applicable federal, state and municipal codes, laws and regulations for exits.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. General: Coordinate the work of this Section with the respective trades responsible for installing anchorages furnished by this Section; make

arrangements for delivery, receipt and installation of inserts and anchorages to prevent delay of the Work.

2. Coordinate the work of this Section with the respective trades responsible for furnishing hardware and installing doors and frames.
3. Ensure that the work performed hereunder is coordinated with issued templates authorized by the hardware supplier.
4. Do not fabricate doors or frames before receiving a copy of the approved hardware schedule, submitted by the hardware supplier, reviewed by the Contractor and accepted by the Architect. Verify that issued templates are coordinated with the approved schedule; immediately notify the Architect, in writing, of any conflicts.

1.5 SUBMITTALS

- A. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 1. Literature: Manufacturer's product data sheets, specifications, for doors, frames and shop applied finishes.
 2. Certification: Manufacturer's written certification stating that doors, frames, and all related items to be furnished hereunder, meet or exceed the requirements specified under this Section; that specified galvanized and shop priming has been performed; and that all UL fire-resistive requirements for the indicated Labels have been met.
 3. Shop drawings: A complete schedule of doors and frames, to be furnished hereunder, coordinated with the door and frame schedule contained in the Contract Drawings. Large scale details of each type door and frame construction, indicating all gages, cut-outs for glazing in doors, reinforcing, and anchorage.

1.6 QUALITY ASSURANCE

- A. General: Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
- B. Sole Source: Obtain doors and frames specified in this Section from a single manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements:
 1. Prior to shipping, identify each frame and door with a removable metal or plastic label which corresponds with door schedule identifying opening number and location.

2. Do not deliver items to the site, until all specified submittals have been submitted to, and approved by, the Architect.
 3. Deliver doors and frames boxed or crated to provide protection during transit and job storage.
 4. Inspect doors and frames upon delivery for damage. Minor damage may be repaired provided the refinished items are equal in respects to new work and acceptable to the Architect; otherwise remove and replace damaged items.
- B. Storage and Handling Requirements:
1. Store and handle materials following manufacturer's recommended procedures.
 2. Store doors and frames at the building site upright and under cover. Place the units on wood dunnage and cover in a manner that will prevent rust and damage.

1.8 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 1. Amweld Building Products, Inc., (A Division of Amweld International, LLC), Coppell TX.
 2. Ceco Door Products (A Division of Assa Abloy Group Company), Milan TN.
 3. Curries Company A Division of Assa Abloy Group Company), Mason City IA.
 4. Essex Industries, Inc. New Haven CT.
 5. Republic Doors and Frames, McKenzie TN.
 6. Steelcraft (A Division of Ingersoll-Rand Company), Cincinnati OH.
- B. Unless otherwise specifically accepted by Architect, all doors and frames shall be of one manufacturer.

2.2 HOLLOW METAL FRAMES

- A. General: Refer to the Drawings for various types of frames, sizes, and profiles, UL fire-resistive Label frames, and other characteristics of frames and related items.
 1. Frame type: Shop welded frames with mitered joints arc-welded, reinforced and ground smooth.
- B. Materials for frames, reinforcement, anchors, anchor clips and related items: commercial grade cold-rolled steel conforming to ASTM A109 or commercial grade hot-rolled and pickled steel conforming to ASTM A415.
 1. Frame gage:
 - a. Interior frames: 16-gage, 0.053 inch thick (1.3 mm), except as otherwise required for specific U.L. Label.
 - b. Exterior frames: 14-gage, 0.067 inch thick (1.7 mm), with a zinc coating supplied by the hot-dip process conforming to ASTM A653, Grade 37, with coating applied in accordance with A 924.
 2. Hinge, lock and strike reinforcement: 7 gage (4.4 mm) thick.
 3. Door closer reinforcement: 12 gage, minimum 0.093 inch (2.3 mm) thick.

4. Floor clips: 16 gage (1.3 mm) thick.
5. Splice plates or channels: same gage as door frame.
6. Glazing stops: 16 gage, minimum 0.053 inch (1.3 mm) thick, except as otherwise required for specific U.L. Label.
7. Mortar guards: 26 gage, minimum 0.016 inch (0.4 mm) thick.

C. Frame construction:

1. Fire-rated frame assemblies: Modify specified construction to meet all construction requirements required for fire-resistive rating.
 - a. Affix appropriate UL, FM or Warnock Hersey labels to each rated frame assembly, indicating applicable rating.
2. Shop-fabricate frames as whole single units per door opening, except when frame size is too large to ship as a single unit. Oversized frames may be shipped in large sections as practicable for field assembly with concealed splice plates or channels.
3. Frame corner construction: As specified in paragraph A, above.
4. Reinforcements, stiffeners, and base angle clips: Welded to interior surfaces of frames to provide a stable base and so as to not interfere with installation of hardware.
5. Provide mortar boxes, welded to frame, at back of hardware cut-outs where mortar or other materials may obstruct hardware operation.
6. Appearance of finished frames: Strong, rigid, completely free from warp and buckle, with miters well-formed and in true alignment, and with surfaces smooth and free from defects of any kind.
7. Silencer holes: Punch three holes in stop of strike jamb of door frames for application of silencers.
8. Glazing beads: Carefully place to properly accommodate the various thicknesses of glass and glazing materials, and loosely-attach to frames with flathead galvanized steel screws through pre-drilled holes having countersunk depressions.

D. Anchorage:

1. Anchor clips for frames in metal stud partitions: 16-gage steel z-shaped clips, 1-1/2 inch upturned and downturned legs, or equivalent type standard with the manufacturer, contained within the frames, for screw attachment to metal studs under Section 09 22 16 - NON-STRUCTURAL METAL FRAMING.
2. Anchor clips for frames in cold-formed metal framed exterior walls: 12-gage steel z-shaped clips, 1-1/2 inch upturned and downturned legs, or equivalent type standard with the manufacturer, contained within the frames, for screw attachment to metal studs under Section 05 40 00 - COLD-FORMED METAL FRAMING.

3. Anchors for frames in masonry walls: Adjustable, T-shaped, positively engaging the retainers on both flanges of each jamb member, when placed. The stem of the anchors shall be 2 inches wide by 12 gage, minimum, corrugated or perforated for mortar bond, and extend 10 inches into the masonry, unless otherwise indicated.
4. Anchors for fire-resistive rated frames: Conform to all UL requirements for the specific fire-resistive ratings.
5. Typical frames: Provide not less than 3 anchors, clips, or bolts (as applicable), per jamb.
 - a. Frames exceeding 3 feet in width, and cross corridor frames: Provide not less than 4 anchors, clips, or bolts (as applicable), per jamb.

2.3 FABRICATION TOLERANCES

- A. Maximum variation for doors and frames: Maximum diagonal distortion 1/16 inch measured with straight edge, corner to corner.

2.4 FACTORY FINISHING

- A. Preparation: Pressure-sand all surfaces of all doors, frames, accessory items, anchors, and related items, to remove blemishes and foreign matter and provide paint grip. Spot-fill imperfections with metallic filler, and sand smooth. Thoroughly clean the surfaces by applying hot or cold phosphate treatment standard with the manufacturer.
- B. Following cleaning apply one dip or spray coat of rust-inhibitive metallic oxide, zinc chromate, or synthetic resin primer to all surfaces, including those which will be concealed after erection. Bake, or oven dry, the primer at time and temperature recommended by the manufacturer for developing maximum hardness and resistance to abrasion.

PART 3 - EXECUTION

3.1 ERECTION AND INSTALLATION

- A. Installation of frames and doors, including all accessories and related items furnished hereunder, will be performed under Section 06 10 00 - ROUGH CARPENTRY.
 1. Section 06 10 00 - ROUGH CARPENTRY shall place frames in correct position within specified tolerances.

End of Section 08 11 10

08 14 00 FLUSH WOOD DOORS**PART 1 - GENERAL**

1.1 SUMMARY

- A. Furnish the following products to be installed under the designated Sections:
1. Flush solid core wood doors, complete with necessary blocking, hardware cutouts.
 2. Wood veneer to match existing doors.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 06 10 00 - ROUGH CARPENTRY: Wood blocking, and nailers; installation of steel door frames.
- D. Section 06 42 00 - Interior Architectural Woodwork: Installation of hardware and doors.
- E. Section 08 11 13 - HOLLOW METAL DOORS AND FRAMES: Hollow metal frames scheduled to receive wood doors.
- F. Section 08 71 00 - DOOR HARDWARE: Furnishing finish hardware, and installation templates for hardware cutouts.

1.3 REFERENCES

- A. Referenced Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 - GENERAL REQUIREMENTS. The standards referenced herein are included to establish recognized minimum quality only. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.
1. ANSI A 117.1 - Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
 2. ANSI A 208.1 - Wood Particleboard.
 3. ASTM E 152 - Methods of Fire Tests of Door Assemblies.
 4. ASTM C 1036 - Flat Glass.
 5. ASTM C 1048 - Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.
 6. ASTM D 523 - Specular Gloss.
 7. ASTM D 5456 - Evaluation of Structural Composite Lumber Products..

8. ANSI Z97.1 - Safety Performance Specifications and Methods of Test for Safety Glazing Used in Buildings.
9. Federal Safety Standards for Architectural Glazing Materials 16CFR1201.
10. NFPA publication 80 - Fire Doors and Windows.
11. WDMA Industry Standard IS 1-A-11.
12. UBC 43.2 – Fire Tests of Door Assemblies.
13. UL 10B - Fire Tests of Door Assemblies.
14. UL 10C – Positive Pressure Fire Door Test Method.
15. Warnock-Hersey - Certification Listings for fire doors.
16. All applicable federal, state and municipal codes, laws and regulations for exits.

1.4 SUBMITTALS

- A. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
1. Literature: Fabricator’s product data sheets, specifications, and performance data.
 2. Certificates: Wood products lacking acceptable documentation for the following will be rejected and their removal required.
 - a. General: Fabricator’s written certification stating that doors, meet or exceed the requirements specified under this Section that specified shop finishing has been performed.
 - b. Provide signed certification by agent of door manufacturer stating that machining, glazing and finishing of doors shall be performed by only by the manufacturer in its facilities.
 - c. Urea-formaldehyde Resins: Written documentation certifying that all composite wood and agrifiber products used on this Project contain no added urea-formaldehyde.
 - 1) Written certification from Millworker, that only “no added urea-formaldehyde” manufactured composite panel products are incorporated into the Work, including all concealed components. Composite panel products include but are not limited to particle board (PB), Medium Density Fiberboard (MDF) and similar manufactured products.
 - 2) Written certification from Millworker that laminating adhesives used in product fabrication on or off site do not contain any added ureaformaldehyde resins.
 3. Door schedule: All doors specified under this Section, coordinated with the both door and hardware schedules contained in the Contract Drawings.
 - a. Indicate doors to be factory finished and finish requirements.
 - b. Indicate fire protection ratings for fire rated doors.
 4. Shop drawings: Elevations, and large scale sections and details of door construction, indicating profiles, core construction, joinery, edges, and cutouts for hardware and glazing and glazing.
 - a. Indicate dimensions and locations of mortises and holes for hardware.
 - b. Indicate dimensions and locations of cutouts.

- c. Indicate requirements for veneer matching.
- 5. Verification samples:
 - a. Corner section of specified flush type door, showing core construction and joinery.
 - b. For transparent finishes: submit two 8 by 10 inch mounted finished samples of each specie of veneer specified.
 - c. Louver blade and frame sections, 6 inches (150 mm) long, for each material and finish specified.
 - d. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.5 QUALITY ASSURANCE

- A. All materials and workmanship shall conform in all respects to the specified grades of the Window and Door Manufacturer's Association (WDMA) Industry Standard IS 1-A-11, except as modified herein.
- B. Sole Source: Obtain doors specified in this Section from a single manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate the work of this Section with the respective trades responsible for furnishing hardware and installing wood doors.
- B. Ensure that the work performed hereunder is coordinated with issued templates authorized by the hardware supplier.
- C. Do not fabricate doors before receiving a copy of the approved hardware schedule, submitted by the hardware supplier, reviewed by the Contractor and approved by the Architect. Verify that issued templates are coordinated with the approved schedule; immediately notify the Architect, in writing, of any conflicts.

1.7 DELIVERY, STORAGE AND HANDLING

- A. The Contractor is responsible to make certain that wood doors are not delivered until the building and storage areas are sufficiently dry so that the doors will not be damaged by excessive changes in ambient humidity and relative moisture content.
- B. Deliver wood doors in resilient non-staining moistureproof packaging, provide protection during transit and job storage. Clearly identify doors with door opening number, matching those indicated on the approved Door Schedule.
- C. Inspect doors upon delivery for damage. Minor damage may be repaired provided the refinished items are equal in respects to new work and acceptable to the Architect; otherwise remove and replace damaged items.
- D. Store doors flat on a level surface, in protected, elevated, dry areas; protect from exposure from all sources of light and moisture. When required to maintain manufacturer's warranty, seal top and bottom edges if stored more than one week. Break packaging seal on-site to permit ventilation.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

1.9 WARRANTY

- A. Provide the following warranties under provisions of Division 01 – GENERAL REQUIREMENTS. Warranties shall include delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction, all as defined by AWI Quality Standards.
1. Warranty length:
 - a. Interior doors: Manufacturer's lifetime warranty.
 2. Warranty coverage shall include all labor and material costs of delivery, rehanging, re-finishing, glass and glazing to produce a complete installation of replaced or repaired doors.

PART 2 - PRODUCTS

2.1 FLUSH FACED DOORS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
1. Algoma Hardwoods, Inc., Algoma WI.
 2. Marshfield DoorSystems™, Inc., Marshfield WI.
 3. Eggers Industries, Architectural Door Division, Two Rivers WI.
 4. Lambton Doors, Lambton Quebec Canada.
 5. VT Industries Inc., Holstein IA.
- B. General Description: Flush wood doors conforming to the requirements set forth in the designated Sections of the Architectural Woodwork Standards, (WDMA) Industry Standard IS 1-A-11, and the applicable requirements of U.S. Commercial Standard CS 171, as amended. Refer to the Drawings for sizes, locations of each type door, glazing cut-outs in doors, and other characteristics of doors to be furnished hereunder.
1. Door Grade: Premium.
 2. Door Facing:
 - a. Face veneer: WDMA Industry Standard, "A' Grade veneer minimum 1/50 inch (0.6 mm) thick, mechanically splice Select White Maple, Quarter Sliced, Grade A with slip matched grain, end matched transoms. No heartwood will be accepted.
 - 1) Matching of adjacent pieces of veneer: Slip matched. 2) Panel face assembly: Center balanced.
 - 2) Face Veneer to match existing doors (Maple)
- C. Regulatory Requirements:
1. Fire rated door construction shall conform to UL publications 10B (neutral pressure testing) and 10C (positive pressure testing).

2. Install doors in compliance with NFPA publication 80.
3. Corridor door assemblies shall be tested and listed per UL 1784.

2.2 FIRE-RESISTANCE RATED 45, 60 AND 90 MINUTE LABEL DOORS

- A. General Construction: WDMA Industry Standard I.S. 1-A-11, S-21 Veneer, Fire Rated Mineral Core, Premium Grade Door.
1. Door thickness: 1-3/4 inches, unless indicated otherwise.
 2. WDMA Specification Descriptions.
 - a. 90 minute "B" label doors: Type"FD-90 MIN-5, HPDL".
 - b. 60 minute label doors: Type"FD-60 MIN-5, HPDL".
 - c. 45 minute "C" label doors: Type"FD-45 MIN-5, HPDL".
- B. Door facing: As specified herein above under Article – "Flush Faced Doors".
- C. Core construction:
1. Core: Fire resistant Non-combustible asbestos free, mineral composite material per label listing requirements. Positive pressure fire doors shall include intumescent when required, meeting UL Category A requirements..
 2. Stiles: multiple-ply stiles with 1/4 inch solid hardwood outer ply matching face veneers for species and color.
 3. Top and bottom rails: Maple, birch, Structural Composite Lumber (SCL) or UL approved composite material to meet label requirements.
 4. Blocking: Provide blocking as required to meet WDMA Extra Heavy Duty performance for securing surface applied hardware without the use of through bolts.
 - a. For doors scheduled to receive screw-mounted surface closers, provide top rail blocking.
 - b. For doors scheduled to receive surface mounted fire exit devices or vertical rods, provide top, intermediate and bottom rail blocking for screw mounting.
 - c. Provide additional blocking for all other surface mounted hardware. D.

Adhesives: Type 1 (waterproof) for both face and core assembly.

- E. Accessories: For all fire-rated doors installed in pairs with both leaves active, provide 20-gage formed steel edges, without astragal, wrapped with veneer matching faces of doors.

2.3 FIRE-RESISTANCE RATED 20 MINUTE LABEL DOORS

- A. General Construction: WDMA Industry Standard I.S. 1-A-11, S-21 Veneer, Fire Rated Mineral Core, Premium Grade Door.
1. Door thickness: 1-3/4 inches, unless indicated otherwise.
 2. WDMA Specification Description: "FD-20 MIN".
- B. Door facing: As specified herein above under Article – "Flush Faced Doors".

- C. Core construction:
 - 1. Core: Particleboard complying with ANSI A208.1 Type 1, Grade 1-LD-2 having a density of 33 pounds per cubic foot.
 - a. Provide only no added urea-formaldehyde particleboard. Furnish certification of formaldehyde free products.
 - 2. Stiles: Stile construction that meets or exceeds WDMA Extra Heavy Duty performance. Structural composite lumber with minimum 1/2" hardwood outer stile of same specie as face veneer, minimum overall 1 inch after trimming
 - 3. Top and bottom rails: Maple, Birch, Structural Composite Lumber (SCL) or UL approved composite material to meet label requirements, minimum 7/8 inch width, after trimming.
- D. Adhesives: Type 1 (waterproof) for both face and core assembly.
- E. Accessories: For all fire-rated doors installed in pairs with both leaves active, provide 20-gage formed steel edges, without astragal, wrapped with veneer matching faces of doors.

2.4 NON-RATED SOLID-CORE DOORS

- A. General Construction: WDMA Industry Standard I.S. 1-A-97, S-9 Veneer, Particleboard Core Bonded, Premium Grade Door.
 - 1. WDMA Specification Description: "PC-5".
 - 2. Door thickness: 1-3/4 inches, unless indicated otherwise.
- B. Door facing: As specified herein above under Article – "Flush Faced Doors".
- C. Core construction:
 - 1. Core: Particleboard complying with ANSI A208.1 Type 1, Grade 1-LD-2 having a density of 33 pounds per cubic foot.
 - a. Provide only formaldehyde free particleboard, equal to Rodman Industries, Oconomowoc, WI. Furnish certification of formaldehyde free products.
 - 2. Stiles: Laminated strand lumber or hardwood mill option for inner ply of styles, continuously bonded to core with adhesives and abrasively planed before veneering, minimum of 1-3/8 inches after trimming, with 1/4 inch solid hardwood outer ply matching face veneer.
 - 3. Top and bottom rails: Maple, Birch, Structural Composite Lumber (SCL) or UL approved composite material to meet label requirements, minimum 1-1/8 inch width.
- D. Adhesives: Type 1 (waterproof) for both face and core assembly.

2.5 GLAZING BEADS

2.6 LOUVERS

- A. Louvers: Extruded aluminum louver, UL and Warnock Hersey International approved, maximum size 24 by 24 inches equal to Construction Specialties Inc., model N°. "FL-138".
1. Fabricated from 6063-T5 alloy aluminum, 0.05 inches thick, furnished with adjustable trim.
 2. Fasteners: High strength aluminum or stainless steel, countersunk into trim.
 3. Finish: Factory primed with baked enamel ready to receive field-applied finish.

2.7 FABRICATION

- A. Fabricate doors in accordance with specified manufacturer's requirements. Fabricated rated doors in compliance with WHI, or UL requirements as appropriate. B. Laminate door facing, cross banding and assembled core in a hot press.
- C. Bond stiles and rails to cores, sand for uniform thickness. Factory sand assembled door leaf.
- D. Factory-machine doors to receive hardware from templates furnished under Section 08 71 00 - DOOR HARDWARE. Do not machine for surface hardware.
1. Provide inner blocks at lock edge and top of door for closer hardware reinforcement.
 2. Cut and configure door edges to receive scheduled gasketing.
- E. Factory fabricate doors for undercut where scheduled. Provide undercuts as required to ensure door clearance at finished flooring.
- F. Factory cut all louver and glazed openings as scheduled. Field cutting of openings is prohibited.
- G. Fabrication tolerances: Maximum diagonal distortion (warp): 1/4 inch (6 mm) measured with straight edge from corner to corner over a maximum 42 by 84 inch surface area.

2.8 FACTORY FINISHING

- A. General: Factory finish to be to comply with EPA Title 5 guidelines for Volatile Organic Compound (VOC) emissions limitations.
- B. Transparent finish: AWI Premium Grade Factory Finish System 9, having water based stain and ultraviolet (UV) cured polyurethane sealer and topcoat, with a satin sheen of 31° to 35° gloss units per ASTM D523.
1. Finish system shall include the following:
 - a. Finish sanding.
 - b. Stain application.
 - c. Stain curing.

- d. Sealer application - first coat.
- e. Sealer gel cure.
- f. Sealer application - second coat.
- g. Sealer gel cure
- h. Sealer application - third coat
- i. Sealer full cure
- j. Sealer sanding
- k. Topcoat application - first coat
- l. Topcoat application - second coat
- m. Topcoat full cure

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation of wood doors, including all hardware and accessories and related items furnished hereunder, will be performed under Section 06 42 00- INTERIOR ARCHITECTURAL WOODWORK.

3.2 TOUCH-UP FINISHES

- A. Field touch-up of doors, scheduled for transparent finishes, will be performed by an authorized representative of the door fabricator. Touch-up includes refinishing surfaces resulting from fitting, or job inflicted scratches and marks.

End of Section 08 14 00

SECTION 08 31 10 ACCESS DOORS AND PANELS**PART 1 - GENERAL**

1.1 SUMMARY

- A. Fire resistive rated and non-rated access panels and frames, as specified under this Section, furnished by Sections requiring the same and installed under the following Sections:
 - 1. Section 09 29 00 - GYPSUM BOARD: Installation of access panels into drywall assemblies.
 - 2. Provide tape in flange, typical.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 09 21 10 - GYPSUM BOARD ASSEMBLIES: Installation of access panels into drywall assemblies.
- D. Division 21 - FIRE SUPPRESSION: Furnishing access panels required for fire protection systems.
- E. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING: Furnishing access panels required for heating/cooling systems.
- F. Division 26 - ELECTRICAL: Furnishing access panels required for electrical systems.

1.3 SUBMITTALS

- A. Information and Review Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 - 1. Product Data: Manufacturer's product data sheets, specifications and installation instructions.
 - 2. Schedule: Submit Schedule of all access panels to be furnished hereunder, indicating locations for each size and type of access door.
 - a. The General Contractor is responsible to ensure that all of the types/styles of panels and frames specified herein can be furnished by the manufacturer submitted.

- b. Prior to submitting schedule, coordinate with the work of Division 21 - FIRE SUPPRESSION, Division 22 - PLUMBING, Division 23 - HEATING, VENTILATING AND AIR CONDITIONING and Division 26 - ELECTRICAL and meet with the Architect to determine exact quantities and locations required for the installation of access panels.
3. Shop drawings: Large scale details of access doors, indicating all sizes, gages and thickness; provide complete installation details, coordinated to the specific receiving conditions.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver access doors to the site, until all specified submittals have been submitted to, and approved by, the Architect.
- B. Store access door units inside, under cover, and in manner to keep them dry, protected from weather, direct sunlight, surface contamination, corrosion and damage from construction traffic and other causes.

1.5 WARRANTIES

- A. General: Submit warranties under provisions of 01 78 39 – PROJECT RECORD DOCUMENTS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 1. Babcock-Davis, Brooklyn Park, MN.
 2. Acudor Products Inc., Cedar Grove, NJ
 3. Cesco Products, North Brooklyn Park MN.
 4. J.L. Industries, Bloomington MN.
 5. Karp Associates Inc., Maspeth NY.
 6. Miami-Carey Corp., Monroe OH.
 7. Nystrom Products Company, Minneapolis MN.
 8. Milcor, Inc. Lima OH.
 9. Larson Manufacturing Co., Brookings SD.
 10. Williams Brothers Corporation of America, Front Royal, VA.
- B. Single Source: All work of this Section shall be produced by a single manufacturer,

unless otherwise approved by the Architect.

2.2 ACCESS PANELS - GENERAL

- A. Provide acoustical insulation and gasketing at all panels.

2.3 ACCESS PANELS - FOR FIRE RESISTANCE RATED CONSTRUCTION

- A. For fire-resistance rated wall and ceiling surfaces: Standard flush panel door (except recessed type at drywall) meeting the following requirements:
 1. Panel and frame rating: UL "B" label for 90 minutes.
 2. Frame type:
 - a. For gypsum board walls and ceilings: 16 gage galvanized bonderized steel frame, with 22 gage galvanized steel drywall bead.
 - 1) Acudor FW-5050DW
 - 2) Karp KRP-350FR series.
 - 3) Nystrom IW series.
 - 4) Williams WB-FR series.
 3. Door: Insulated Flush panel door as follows:
 - a. Typical wall types: Flush door, Sandwich construction with 2 inch thick mineral wool fiber insulation between two layers of 20 gage galvanized bonderized steel.
 4. Hinge: Flush continuous piano hinge with stainless steel pin.
 5. Closer: Spring closer.
 6. Latch: Flush cam latch, operated by Allen or Torx head screwdriver.

2.4 ACCESS PANELS - FOR NON- RATED CONSTRUCTION

- A. For non-rated gypsum board, walls and ceilings: Recessed door type meeting the following requirements
 1. Manufacturer's types:
 - a. Acudor DW-5015 series.
 - b. Karp:
 - 1) Walls: Karp RDW series.
 - 2) Ceilings: Karp KATR series.
 - c. Nystrom RW series.
 - d. Williams WB-DW series.
 2. Frame type: 16 gage galvanized bonderized steel frame, with 22 gage galvanized steel drywall bead.
 3. Door: Recessed 16 gage galvanized bonderized steel door. with 22 gage

galvanized steel drywall bead.

4. Hinge: Concealed pivot rod hinge.
5. Latch: Flush cam latch, (operated by Allen or Torx head screwdriver) with steel grommet welded to door.

2.5 FACTORY FINISHING

- A. Panel assemblies fabricated from galvanized bonderized steel: Baked on rust inhibitive gray primer finish.
- B. Panel assemblies fabricated from cold rolled steel: Phosphate dipped with baked on rust inhibitive gray primer finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect all surfaces and verify that they are in proper condition to receive the work of this Section. Verify that prepared openings are ready to receive the work of this Section and opening dimensions are as indicated on the shop drawings. Verify that all blocking is set in place and secure.
- B. Beginning of installation means acceptance of project conditions.

3.2 INSTALLATION

- A. Install access panels in accordance with manufacturer's instructions and direction from authorities having jurisdiction. Install miscellaneous specialties absolutely level and in true line, with units securely anchored to the surrounding construction.
- B. Test each door and latching device, and make adjustments required to ensure a bind-free operation and proper latching.

End of Section 08 31 10

SECTION 087100 – DOOR HARDWARE**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.

- B Related Sections:

1. Division 01 Section "Closeout Procedures"
2. Division 06 Section "Rough Carpentry".
3. Division 08 Section "Door Hardware Schedule".
4. Division 08 Section "Hollow Metal Doors and Frames".
5. Division 08 Section "Flush Wood Doors".
6. Division 28 Section "Access Control".

- C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

- D. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series

2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- D. Door Hardware Standards and Guidelines: Prepare Door Hardware specification documents in accordance with the Owner's approved ASSA ABLOY Virtual Design Guide (VDG) standard for door opening products and applications.

- E. Building Information Modeling (BIM) Qualifications: BIM software tools and processes are used to produce and support data integration of product and technical information used in specifications, submittals, project reviews, decision support, and quality assurance during all phases of Project design, construction, and facility management. Door and hardware schedules and the associated product data parameters are to be derived, updated, and fully integrated with the coordinated BIM.
1. Door Hardware BIM Software Tool: Openings Studio™ is the designated BIM software suite to be used in a coordinated effort with architects, contractors and trades to integrate Project product data and information into the coordinated Record BIMs and associated applications..
- F. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
1. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- G. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- H. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
1. Function of building, purpose of each area and degree of security required.
 2. Plans for existing and future key system expansion.
 3. Requirements for key control storage and software.
 4. Installation of permanent keys, cylinder cores and software.
 5. Address and requirements for delivery of keys.
- I. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.
 4. Review and finalize construction schedule and verify availability of materials.
 5. Review the required inspecting, testing, commissioning, and demonstration procedures

- J. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.
- D. Building Information Modeling (BIM) Support: Utilize designated BIM software tools and obtain training needed to successfully participate in the Project BIM processes. All technical disciplines are responsible for the product data integration and data reliability of their Work into the coordinated BIM applications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Five years for exit hardware.
 - 3. Twenty five years for manual surface door closer bodies.
 - 4. Twenty five years for manual surface door closer bodies.
 - 5. Twenty five years for manual surface door closer bodies.
 - 6. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 5. Manufacturers:
 - a. Hager Companies (HA) - CB Series.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - TA Series.
 - c. Stanley Hardware (ST) - CB Series.

- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cutouts.

1. Manufacturers:

- a. Hager Companies (HA).
- b. Ives (IV).
- c. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

- a. Hager Companies (HA) - ETW-QC (# wires) Option.
- b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) Option.
- c. Stanley Hardware (ST) - C Option.

- B. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a 12" removable service panel cutout accessible without demounting door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

- a. Bommer Industries (BO) - SER-QC (# of wires) Option.
- b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - SER-QC (# wires) Option.
- c. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) - SERQC (# wires) Option.

- C. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door

wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:
 - a. Adams Rite (AD) – 4612 Series.
 - b. Securitron (SU) - EL-EPT Series.

D. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to throughdoor wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.
2. Manufacturers:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC-C Series.
 - b. Stanley Hardware (ST) – WH Series.

2.4 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 2. Furnish dust proof strikes for bottom bolts.
 3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 5. Manufacturers:
 - a. Door Controls International (DC).

- b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).
- B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
 - 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 - 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
 - 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 - 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 - 5. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. Cylinders: Original manufacturer cylinders complying with the following:
 - 1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
 - 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 - 4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 5. Keyway: Match Facility Restricted Keyway.
- D. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- E. Patented Cylinders: ANSI/BHMA A156.5, Grade 1, certified patented cylinders employing a utility patented and restricted keyway requiring the use of a patented key. Cylinders are to be protected from

unauthorized manufacture and distribution by manufacturer's United States patents. Cylinders are to be factory keyed with owner having the ability for on-site original key cutting.

1. Manufacturers:
 - a. Medeco (MC) - X4 Series.
 - b. No Substitution.

- F. Keying System: Each type of lock and cylinders to be factory keyed.
 1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 3. Existing System: Key locks to Owner's existing system.

- G. Key Quantity: Provide the following minimum number of keys:
 1. Change Keys per Cylinder: Three (3).
 2. Master Keys (per Master Key Level/Group): Five (5).
 3. Construction Keys (where required): Ten (10).
 4. Construction Control Keys (where required): Two (2).
 5. Permanent Control Keys (where required): Two (2).

- H. Construction Keying: Provide temporary keyed construction cores.

- I. Key Registration List (Bitting List):
 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 2. Provide transcript list in writing or electronic file as directed by the Owner.

- J. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
 1. Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

- K. Key Control Software: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge. Provide factory key system formatted for importing into "Key Wizard" software.

2.6 DIGITAL ELECTRONIC CYLINDERS AND KEYS

- A. Digital Cylinders: Provide original manufacturer cylinders to meet the following minimum requirements:

1. Provide cylinders to retrofit into new or existing hardware without modifications. Provide cylinders and keys with integral power without the need for wires or electricity.
2. Provide electronic access control functions for rim, mortise, or key-in-lever cylinder types, and auxiliary locks (deadbolts, padlocks, cam locks) as specified in the hardware sets listed under Part 3.
3. Communications between cylinder/key/software are AES encrypted.
4. Provide system compatibility with small format interchangeable core cylinder systems.
5. Cylinders to provide access control functions with non-volatile system programming allowing loss of battery life to retain key access rights, and/or audit records.
6. 2000 audit events stored in cylinder.
7. Electronic only cylinder powered by the key.

- B. Digital Keys: Provide original manufacturer keys to meet the following minimum requirements:

1. Single, multi-function keys perform all user, administrative, and core removal operations.
2. Key and cylinder shall be designed for use on interior and exterior with a operating temperature of -40 Degrees F to 140 Degrees F.
3. Provide special industrial keys with hardened stainless steel housings.
4. Provide keys which are bundled with individual wall outlet chargers and USB cables.
5. Up to 1800 openings per charge.
6. Keys automatically power down when left in the cylinder.
7. Access 16,000 cylinders maximum.
8. Audit 10,000 events maximum.
9. All programming done at key.

- C. Manufacturers

1. Medeco High Security Locks (MC) -XT Series.

2.7 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 10 million cycles.
2. Provide mortise lock bodies functionally compatible with a rose-less lever trim option.
3. Manufacturers:
 - a. Sargent Manufacturing (SA) – 8200 Series.
 - b. No Substitution.

2.8 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): Subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below.

1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.
2. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
3. Manufacturers:
 - a. Sargent Manufacturing (SA) - 8200 Series.
 - b. No Substitution.

2.9 AUXILIARY LOCKS

A. Mortise Deadlocks, Small Case: ANSI/BHMA A156.36, Grade 1, small case mortise type deadlocks constructed of heavy gauge wrought corrosion resistant steel. Steel or stainless steel bolts with a 1" throw and hardened steel roller pins. Deadlocks to be products of the same source manufacturer and keyway as other specified locksets.

1. Manufacturers:
 - a. Sargent Manufacturing (SA) - 4870 Series.
 - b. No Substitution.

2.10 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 4. Dustproof Strikes: BHMA A156.16.

2.11 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
 2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
 3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
 4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 5. Flush End Caps: Provide flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.

6. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.
 7. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
 8. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 9. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 10. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 11. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 12. Extended cycle test: Devices to have been cycle tested in ordinance with ANSI/BHMA 156.3 requirements to 50 million cycles.
 13. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 14. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
 - a. Sargent Manufacturing (SA) - 80 Series.
 - b. No Substitution.
- C. Tubular Panic Devices: Certified panic devices conforming to ANSI/BHMA A156.3, Grade 1 Certified complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Device to be ADA compliant requiring less than 5 lbs. of force to activate and meet California Building Code (2013) Sec 11B.309.4. Post mounting with optional mechanical dogging. Provide proper fasteners as required

by manufacturer to meet application requirements. Provide exit devices on both leaves of pairs of doors.

1. Style: Exposed vertical rod. 1-1/4" grip diameter with interior operating panic handle in combination with exterior fixed pull handle. Panic mechanism shall be concealed within brass or stainless steel tubing. Optional entrance from exterior by a keyed cylinder.
2. Configurations (provide as specified):
 - a. Full Height L-Shape Pull. PDU / DDU XXXX-3
3. Push/pull operation when dogged from the inside.
4. Latching: Top latching. Reversed, flat, Pullman style. Roller-type latching not acceptable.
5. Engraved "PUSH" signage with optional paint infill and boundary grooves.
6. Manufacturers:
 - a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO) - PDU8500 Series
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO) - DDU8500 Series (Dummy Device)

2.12 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Manufacturers:
 - a. Sargent Manufacturing (SA) - 351 Series.
 - b. No Substitution.

2.13 ELECTROHYDRAULIC DOOR OPERATORS

- A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.
1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
- B. Standard: Certified ANSI/BHMA A156.19.
- C. Performance Requirements:
1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
 2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.
- D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.
- E. Certification: Furnish Operators with GreenCircle Certification.
- F. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by

ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.

- G. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.
- H. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
- I. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.
- J. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Norton Door Controls (NO) - 6000 Series.

2.14 SURFACE MOUNTED CLOSER HOLDERS

- A. Electromagnetic Door Holders: Certified ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate 12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.
 - 1. Manufacturers:
 - a. Rixson (RF) - 980/990 Series.
 - b. Sargent Manufacturing (SA) - 1560 Series.

2.15 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 - 1. Manufacturers:
 - a. Burns Manufacturing (BU).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

C. Trimco (TC).

2.16 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer. F. Manufacturers:
1. National Guard Products (NG).
 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 3. Reese Enterprises, Inc. (RE).

2.17 ELECTRONIC ACCESSORIES

- A. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.
1. Manufacturers:
 - a. Sargent Manufacturing (SA) - 3500 Series.

b. Securitron (SU) - BPS Series.

- B. Energy Efficient Switching Power Supplies: Provide UL listed or recognized filtered and regulated power supplies. Provide single voltage units as shown in the hardware sets. Units must have one access control input and one fire alarm input. Standby power consumption of unit must be less than 10mW at 120VAC. Provide integral battery backup as standard for all units. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Manufacturers:

a. Securitron (SU) – EPS Series.

2.18 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.19 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch-Out Report): Reference Division 01 Section "Closeout Procedures". Final inspect installed door hardware and state in report whether work complies with or deviates from specification requirements, including whether door hardware is properly installed, operating and adjusted.

- B. Fire Door Assembly Inspection: Reference Division 01 Sections "Closeout Procedures" and "Cash Allowances" for testing and inspection allowances, including cost of engaging testing agencies, performing on-site inspections, and required documentation reporting.
 - 1. Allowance to perform the inspection and provide report documentation for an initial Fire Door Assembly Inspection upon completion of final hardware installation. A qualified fire door assembly (FDAI) inspector to certify swinging fire door openings are installed in accordance and NFPA 80 Standard for Fire Doors and Other Opening Protectives paragraph 5.2.4, regulatory compliance agencies, and local Authorities Having Jurisdiction (AHJ).
- C. Opening Tags: Affix readable, QR-type label to openings with password protected link-out to Openings Studio™ BIM software suite and the installed door and hardware information.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

- B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door. C. Refer to Section 080671, Door Hardware Sets, for hardware sets.

END OF SECTION 087100

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SECTION 09 21 10 - GYPSUM BOARD ASSEMBLIES**PART 1 – GENERAL**

1.1 SUMMARY

- A. The work of this Section consists of gypsum board (drywall) and trim finishes for partitions, ceilings, and soffits, where shown on the Drawings, as specified herein, and as required for a complete and proper installation.
- B. Furnish and install:
 - 1. Taped, compounded and sanded gypsum board finishes.
 - 2. Moisture and mold resistant board.
 - 3. All trim and accessory components related to gypsum board work.
 - 4. Acoustical joint sealant and backing at perimeter of gypsum board partitions.
 - 5. Acoustical insulation at interior partitions.
 - 6. Acoustical mastic at all wall mounted devices.
- C. Install access panels occurring in gypsum board work furnished by Section 08 31 00 - ACCESS DOORS AND PANELS, and by trades requiring the same.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 06 10 00 - ROUGH CARPENTRY:
 - 1. Supplemental wood blocking supporting gypsum board.
 - 2. Installation of metal door frames in gypsum board work.
- D. Section 08 11 13 - HOLLOW METAL DOORS AND FRAMES: Furnishing steel door frames.
- E. Section 08 31 13 - ACCESS DOORS AND FRAMES: Shop primed access panels, occurring in partitions and walls.
- F. Section 09 22 16 - NON-STRUCTURAL METAL FRAMING:
 - 1. Non-load bearing partition, ceiling and soffit framing and furring.
 - 2. Deflection track assemblies at tops of metal stud partitions.
- G. Section 09 90 00 – PAINTING AND COATINGS: Applied finish coatings.
- H. Division 21 - FIRE SUPPRESSION: Sprinkler heads in ceiling system.
- I. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING: Supply and return air

registers.

- J. Division 26 - ELECTRICAL: Independent hangers for suspended lighting fixtures.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 1. ASTM C 475 - Joint Treatment Materials for Gypsum Wallboard Construction.
 2. ASTM C 630 - Water Resistant Gypsum Backing Board.
 3. ASTM C 754 - Installation of Steel Framing Members to Receive Screw-Attached Gypsum Board.
 4. ASTM C 919 - Use of Sealants in Acoustical Applications.
 5. ASTM C 1002 - Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 6. ASTM C 1047 - Accessories for Gypsum Wallboard and Veneer Base.
 7. ASTM C 1396 - Gypsum Wallboard.
 8. ASTM D 3678 - Polyvinyl chloride material for indoor exposure.
 9. ASTM D 1784 - Polyvinyl chloride material for outdoor exposure.
 10. ASTM E 90 - Method of Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
 11. ASTM E 119 - Fire Tests of Building Construction and Materials.
 12. GA 201 - Gypsum Board for Walls and Ceilings.
 13. GA 214 - Recommended Specifications for Levels of Gypsum Board Finish, Glass Mat and Fiber-Reinforced Gypsum Panels.
 14. GA 216 - Recommended Specifications for the Application and Finishing of Gypsum Board.
 15. GA 220 - Recommended Specifications for Gypsum Board Winter Related Job Problems.
 16. UL - Fire Resistance Directory.
 17. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 18. All applicable federal, state and municipal codes, laws and regulations regarding flammability and smoke generation of interior finishes.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. General: Coordinate the work of this Section with the respective trades responsible for installing interfacing and adjoining work for proper sequence of installation, and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.
2. Work of this Section shall be closely coordinated with the work of Section 09 22 16 - NON-STRUCTURAL METAL FRAMING, to assure the steady progress of the Contract.

B. Sequencing: Do not install gypsum board until all pipes, ducts, conduits, and other such items which are to be enclosed thereby, have been permanently installed, inspected and approved.

1.6 SUBMITTALS

A. Information and Review Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:

1. Product Data: Manufacturer's product data sheets, specifications, performance data, physical properties for each item furnished hereunder.
2. Shop Drawings:
 - a. Details of any special conditions associated with fireproofing.
 - b. Mark-up a set of blackline interior elevations indicate corrections to grid layout and provide dimensioning showing locations of all proposed control joints and expansion joints.
 - 1) Provide interior elevation drawings for interior elevations which are not included as part of the Contract Drawing set.
3. Sustainable Design Submittals:
 - a. Provide the following LEED submittal items:
 - 1) All relevant supporting documentation, as required by LEED v4 and as detailed in Section 01 81 13 - SUSTAINABLE DESIGN REQUIREMENTS.
 - 2) A completed LEED Materials Reporting Form, per Section 01 81 13 -SUSTAINABLE DESIGN REQUIREMENTS.

1.7 QUALITY ASSURANCE

- A. General: Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
- B. Sole Source: Obtain products required for the Work of this Section from a single manufacturer, or from manufacturers recommended by the prime manufacturer of gypsum board.

1.9 DELIVERY, STORAGE AND HANDLING

A. Delivery and Acceptance Requirements:

1. Do not deliver items to the site, until all specified submittals have been submitted to, and approved by, the Architect.
2. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.
3. Storage and Handling Requirements: Store materials inside, under cover and in manner to keep them dry, protected from weather, direct sunlight, surface contamination, corrosion and damage from construction traffic and other causes.
 - a. Neatly stack board materials flat to prevent sagging.
4. Handle board materials so to prevent damage to edges, ends and surfaces.
5. Protect trim, accessories and corner beads from being bent or damaged.

1.10 SITE CONDITIONS

- #### A. Environmental Conditions: In accordance with GA 216, maintain minimum ambient temperature of 50 degrees Fahrenheit 48 hours before, during taping and compounding, and until completely dry thereafter.

1.11 WARRANTIES

- #### A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- #### A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:

1. Gypsum board products:
 - a. United States Gypsum Company, Chicago, IL. (USG).
 - b. National Gypsum Company, Gold Bond Products Division, Charlotte, NC. (Gold Bond).
 - c. G-P Gypsum Corporation, Atlanta, GA.
 - d. Lafarge Corporation, Hendron, VA.
2. Acoustical glass fiber insulation:
 - a. CertainTeed Corporation, Valley Forge PA.
 - b. Johns Manville Building Insulation, Denver, CO
 - c. Owens Corning Fiberglas Corp., Toledo OH.
 - d. Schuller International, Inc., Denver CO.
 - e. USG Corp./ USG Interiors Inc., Chicago IL.
3. Polyvinyl chloride trim and accessories:

- a. Plastic Components, Inc., Miami FL.
 - b. Vinyl Corporation, Miami FL.
 - c. Alabama Metal Industries Corporation, (AMICO)Birmingham, AL.
4. Reveal trim:
- a. Fry Reglet Corporation, Norcross GA.
 - b. Gordon Inc., Shreveport LA.
 - c. Pittcon Industries, Inc., Riverdale MD.
 - d. Stockton Products, North Las Vegas, NV.
 - e. Joint Sealants: Tremco, Beachwood, OH.
 - f. United States Gypsum Company, Chicago, IL.
 - g. Pecora Corporation, Harleysville, PA.
- B. The design and details as shown on the Drawings and the model numbers specified herein are to establish the standards of design and quality and not to limit competition.

2.2 DESCRIPTION

- A. Regulatory Requirements:
1. Obtain certificate of compliance from authority having jurisdiction indicating approval of specified products.
 2. Fire resistance ratings: Where gypsum board systems with fire-resistance ratings are indicated, provide materials and assemblies of the rating required, tested per ASTM E 119, which are identical to those indicated by reference to Gypsum Association file numbers in "Fire Resistance Design Manual" or to design designation in the Underwriters Laboratories "Fire Resistance Directory" or in listing of other testing agencies acceptable to authorities having jurisdiction and to the Owners' insurance underwriters.

2.3 BOARD MATERIALS

- A. Non-rated and fire rated gypsum board (for wall fire resistant ratings 120 minutes and less): UL fire resistance rated, ASTM C 1396 'Type X' board, 5/8 inch thick, 48 inch width, of lengths to minimize end joints, with tapered edges.
1. Acceptable products include the following, or approved equal:
 - a. USG Sheetrock brand "Firecode Core"
 - b. National Gypsum Company, Gold Bond brand product: "Fireshield Gypsum Board".
 - c. G-P Gypsum Corporation product: "ToughRock Fireguard".
 - d. Lafarge Corporation, product: "Firecheck Type X".
- B. Sag-resistant interior gypsum board ceiling panels: Non-rated 1/2 inch thick, 48 inch width, of lengths to minimize end joints, with tapered edges, conforming to ASTM C1395 and ASTM C1396.
1. Acceptable products include the following or approved equal:
 - a. USG Sheetrock brand product "Interior Ceiling Panel, Sag Resistant".

- b. National Gypsum Company, Gold Bond brand product "High Strength Ceiling Board".
 - c. G-P Gypsum Corporation product, "ToughRock CD Ceiling Board".
 - d. Lafarge Corporation, product "Sagcheck".
 - 2. At fire-resistant rated ceilings, provide 5/8 inch thick fire-rated gypsum board as specified herein.
- C. Abuse-Resistant Gypsum Board (ARGB): UL type FRX fire resistance type, ASTM C-1278 board, complying with ASTM C1658 and ASTM C36.
 - 1. ASTM C1629 Test Result Characteristics, minimum Level ratings:
 - a. Abrasion: Level 2. Indentation: Level 1.
 - b. Soft Body Impact: Level 2.
 - c. Hard Body Impact: Level 1.
 - 2. Acceptable products include the following or approved equal:
 - a. USG Sheetrock brand product "Moldtough AR", or "Fiberoak AR panels".
 - b. National Gypsum Company, Gold Bond brand product "Hi Abuse XP".
 - c. G-P Gypsum Corporation product, "Dense Armor Plus Abuse".
 - d. Continental Building Products, product "Protecta AR 100 Type X with Mold Defense".
- D. Paperless moisture and mold resistant board: 5/8 inch thick Glass mat, water-resistant, mold-resistant interior wall panel: Coated inorganic glass mat-faced, with Type "X" water-resistant, treated core gypsum wallboard. Physical properties conforming to the applicable sections of ASTM C 1177 and ASTM D3273.
 - 1. Acceptable products include the following or approved equal:
 - a. USG Sheetrock brand product: "Mold-Tough Firecode X".
 - b. G-P Gypsum Corporation product: "DensArmor Plus Paperless Interior Panel.
 - c. Lafarge Corporation, product: "Weather Defense Platinum Interior, Type X".

2.4 ACCESSORIES

- A. Acoustical mastic: Provide at all walls with STC ratings of 49 or higher at wall mounted devices.
 - 1. Kinetics Noise Control, Inc., Dublin, OH., product "Isobacker"
 - 2. Pabco Gypsum, Newark, NJ., (Quiet Rock brand) product "Quiet Putty."
- B. Decorative reveals: Nominally 5/8 inch deep reveal channel with punched tapered fins.
 - 1. Pittcon Softforms, model number: SWR-013-063.
- C. Corner trim: Extruded aluminum trim nominally 5/8 inch deep reveal channel with punched tapered fins.
 - 1. Fry Reglet Corporation, model number: DMCT-375.
- D. Control joint trim: Extruded aluminum trim with 1/4 inch wide recess by nominally 5/8 inch deep reveal channel with punched tapered fins.

1. Fry Reglet Corporation, model number: DRM-625-25
 2. Gordon Inc.: R-Series, 514-5/8.
 3. Pittcon Industries, Inc., model number: SWR-025-063.
 4. Stockton Products, model number: DRM, X=1/2, Y=1/4
- E. Reveal trim: "F" shape extruded aluminum trim with 1/4 inch wide recess by nominally 5/8 inch deep reveal with punched tapered fins.
- F. Fry Reglet Corporation, model number: DRMF-50-25 or approved equal. Acoustical batt insulation at non-rated walls and partitions: Unfaced glass fiber insulation nominal 3-1/2 inches [89mm] thick conforming to ASTM C 665 Type I, of width appropriate for spacing of framing or furring members with which used.
1. Flame Spread Classification: Class A (less than 25, per testing by NFPA 255, ASTM E-84 or UL 723).
- G. Polyvinyl chloride (PVC) trim accessories, conforming to ASTM D 1784 and C 1047.
1. J Bead: Edge trim with exposed 1/2 inch face cap, furnish trim model number corresponding to the board thickness where installed.
 - a. Plastic Components model number: 200X-50 (for 1/2 inch thick board) or 200S-58 (for 5/8 inch thick board).
 - b. Vinyl Corp. model number: JB50 (for 1/2 inch thick board) or JB58 (for 5/8 inch thick board).
 - c. AMICO. model number: AMJB50 (for 1/2" thick board) or AMJB58 (for 5/8" thick board).
 2. L Bead: casing edge trim, furnish trim model number corresponding to the board thickness where installed
 - a. Plastic Components model number: 221-50 (for 1/2 inch thick board) or 221-58 (for 5/8 inch thick board).
 - b. Vinyl Corp. model number: SB50 (for 1/2 inch thick board) or SB58 (for 5/8 inch thick board).
 - c. AMICO. model number: AMSB50 (for 1/2 inch thick board) or AMSB58 (for 5/8 inch thick board).
 3. L-Bead with removable leg: Casing edge trim for joints at ceilings doors and windows, with removable leg strip, furnish trim model number corresponding to the board thickness where installed
 - a. Plastic Components model number: 224-50 (for 1/2 inch thick board) or 224-58 (for 5/8 inch thick board).
 - b. Vinyl Corp. model number: CT-50(for 1/2 inch thick board) or CT-58 (for 5/8 inch thick board).
 - c. AMICO product "Zip Strip" model number: AMZIP50 (for 1/2 inch thick board) or AMZIP58 (for 5/8 inch thick board).
 4. Corner beads, 90 degree with 1-1/4 inch flanges:
 - a. Plastic Components model number: 209.
 - b. Vinyl Corp. model number: CB125.
 - c. AMICO. model number: AMCB125.

5. Control joints: "V" type joint with nominal 3/16 inch reveal and removable temporary tape:
 - a. Gold bond model "EZ Strip Expansion Joint".
 - b. Plastic Components model number: 2027-16.
 - c. Vinyl Corp. model number: CJV16.
 - d. AMICO. model number: AMDCJV16.

- H. Tapes and compound:
 1. Joint tape (at paper-faced gypsum): Nominal 2 inch wide, high strength, cross-fibered paper drywall tape. Joint tape (at fiberglass faced gypsum): Nominal 2 inch wide, self adhering (adhesive backed), fiberglass mesh tape.
 2. Joint Compound for setting fiberglass joint tape:
 - a. Cetainteed, Valley Forge PA., product "ProRock Moisture and Mold Resistant 90".
 - b. Georgia Pacific Gypsum LCC., Pittsburgh PA, product "Densarmor Cote"
 - c. CTS Cement Manufacturing Corporation, Cypress CA., product "Rapid Set OnePass".
 3. Joint Compound for setting paper joint tape: 'Speed-setting type compound', field mixed.
 - a. Acceptable products, or approved equal:
 - 1) USG product "Durabond 20".
 - 2) Gold bond product "Stay Smooth 30".
 - 3) Georgia Pacific Gypsum LCC, product "ToughRock All-Purpose Dry Mix"
 4. Joint Compound for finishing: field mixed joint compound or factory pre-mixed compound.
 - a. Field-mixed compounds: acceptable products, or approved equal:
 - 1) USG product "Durabond 90".
 - 2) Gold bond product "Stay Smooth 90".
 - 3) Georgia Pacific Gypsum LCC, product "ToughRock Setting Compound 90".
 - b. Factory pre-mixed compounds: acceptable products, or approved equal:
 - 1) USG product "Ready-Mixed Joint Compound".
 - 2) Gold bond product "All Purpose Compound".
 - 3) Georgia Pacific Gypsum LCC, product "ToughRock Ready Mix All-Purpose Compound"

- I. Fasteners (interior board systems):
 1. Type S, bugle head screws complying with ASTM C 1002, for applying gypsum board to metal framing, ceiling grid system, and furring channels.
 - a. Not less than 1 inch long for single layer gypsum board.
 - b. Not less than 1-5/8 inch [41mm] long for double-layer gypsum board.
 2. Type W, bugle head screws complying with ASTM C 1002, for applying gypsum board to wood plywood backing, and blocking
 - a. Not less than 1-1/4 inch [31mm] long for single layer gypsum board

- b. Not less than 1-5/8 inch [41mm] long for double-layer gypsum board,
 - 3. Type S-12, fine thread self-drilling screws complying with ASTM C 1002, for applying gypsum board to light gage metal framing.
 - a. Not less than 1 inch [25 mm] long for 1/2 inch thick single layer gypsum board.
 - b. Not less than 1-1/4 inch [31mm] long for 5/8 inch thick single layer gypsum board.
- J. Not less than 1-5/8 inch [41mm] long for double-layer gypsum board, Ceiling buttons, perforated type, 1 inch diameter, for use at multiple layered gypsum board ceiling systems.
- K. Laminating adhesive: USG Durabond Joint Compound 90, USG Ready-mixed All Purpose Compound, or equal.
- L. Joint Sealers (interior acoustical sealant type): One component acrylic latex, permanently elastic, non-staining, non-shrinking, non-migrating and paintable. Acceptable products include the following, or approved equal.
 - 1. Tremco, Beachwood OH; product, "Acoustical Sealant".
 - 2. United States Gypsum Company, Chicago IL; product "USG Acoustical Sealant".
 - 3. Pecora Corporation, Harleysville PA; product " AC-20 FTR".
- M. Liquid sealer for cuts, holes and ends of moisture resistant board; provide one of the following or acceptable equal.
 - 1. Shellac type sealer: mix 4 pounds of orange or bleached shellac dissolved in 1 gallon of denatured ethyl-alcohol.
 - 2. Varnish type sealer: Fast setting marine varnish.
- N. Spot grout: Provide grout complying with ASTM C 475 for setting type joint compound recommended for spot grouting hollow metal door frames.

2.5 SOURCE QUALITY CONTROL

- A. Obtain gypsum board products from a single manufacturer, or from manufacturers recommended by the prime manufacturer of gypsum boards.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that all items which are to be enclosed by Work of this Section, have been permanently installed, inspected and approved.
- B. Inspect framing and other substrates; verify that they are in proper condition to receive the work of this Section.
- C. Beginning of installation means acceptance of existing substrate and site conditions.

3.2 PREPARATION

- A. During the operation of gypsum board work, protect all wood, metal, glass, flooring, and other finished materials against undue soilage and damage by the exercise of reasonable care and precautions. Repair or replace any work so damaged and soiled.

3.3 INSTALLATION - GENERAL

- A. General: Perform erection procedures for the various gypsum board system conditions, except as otherwise specified, as set forth in GA 201, GA 216, GA 220, the written instructions of gypsum board manufacturer, together with the additional requirements specified herein and as indicated on the Drawing. Where fire-resistive rated assemblies are indicated, erect gypsum board systems in strict accordance with the manufacturers' UL listed test constructions for the required fire rating on each specific assembly.
- B. Install specified control joints where indicated on Drawings and where run of partitions, or furred surfaces exceeds 30 feet. Show locations of all control joints on shop drawings.
 - 1. Locate control joints at corners of head frames of doors.
 - 2. Run vertical control joints continuously to top of partition, shaft wall or furred area, as applicable.

3.4 INSTALLATION OF GYPSUM BOARD

- A. Screw fasten only, gypsum board to framing and furring, with ends and edges occurring over firm bearing. At all door jambs screw fasten gypsum panels 8 inches on center to both box studs
 - 1. Erect single layer fire-resistance rated gypsum board vertically.
 - 2. Erect standard and moisture resistant layer board in most economical direction.
 - 3. Erect ceiling and soffit gypsum boards to meet UL requirements, where applicable, stagger end joints over supports. Secure gypsum board with fasteners inserted through ceiling buttons; anchor fasteners directly to framing or suspended support system.
- B. Wherever items penetrate the gypsum board surfaces, use extra care in cutting the gypsum board to ensure a uniformly-dimensioned joint between the penetrating item and the gypsum board, and fill joints with specified sealant material. Verify the expected deflection factor of the penetrating members, and cut the gypsum accordingly, to prevent damage thereto from the deflecting members.
- C. Treat cut edges and holes in moisture resistant gypsum board with approved liquid sealer.
 - 1. If shellac is used, apply in thin layers to dry quickly.

3.6 INSTALLING PVC TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same screw fasteners used for gypsum board. Otherwise, attach trim according to manufacturer's written instructions.
 - 1. Nailing, stapling, or crimping methods to install trim components is prohibited.
- B. Install corner beads at all exterior corners of gypsum boards.
- C. Install casings (PVC trim) wherever gypsum board meets a dissimilar material, and in other locations indicated on the Drawings, except at floors where bottom of the board will be concealed by base, integral with flooring, resilient base, wood base or carpeted base.

3.7 INSTALLATION OF ACOUSTICAL INSULATION

- A. Install insulation in accordance with insulation manufacturer's instructions. Install in interior walls, and ceiling spaces where indicated. Trim insulation neatly to fit spaces. Fit insulation tight in spaces. Leave no gaps or voids.

3.8 APPLICATION OF ACOUSTICAL SEALANT

- A. General: Install sealant and backing in accordance with the recommendations of ASTM C-919 and sealant manufacturer's recommendations.
 - 1. Perform preparation in accordance with C-790. Thoroughly clean all joints, removing all loose mortar, oil, grease, dust, frost, and other foreign materials that will prevent proper adhesion of primers and sealant materials.
 - 2. If so recommended and furnished by the specific sealant manufacturer, apply primer to all joint surfaces, taking care not to stain adjacent surfaces.
- B. Seal all partition perimeters prior to taping or compounding. Where perimeters are edged with metal trim, apply sealant and backing material between trim and dissimilar material.
- C. Seal all penetrations in all partitions. Penetrations to receive sealant include electrical boxes, plumbing, heating and air conditioning ducts, telephone, intercom hookups and similar items.
 - 1. Install joint bead back-up in all joints in excess of 5/8-inch depth, and joints that have no back-up therein, placing the joint bead in the joint in a manner that will assure a constant depth 1/8 inch greater than the sealant and caulking material depth tolerances.
 - a. Set beads into joints continuously, by slightly stretching during placement, to permit compression against sides of joint, without surface wrinkles or buckles.
 - b. Do not stretch back-up material into joints.
 - c. Install bond breaker wherever recommended by the sealant manufacturer to prevent bond of the sealant to surfaces where such bond might impair the Work.
 - 2. Apply sealant in continuous beads without open joints, voids or air pockets

- a. The depth of sealant and caulking materials shall be in accordance with manufacturer's recommendations for the specific joint function, but in no case exceed 1/2-inch in depth, nor less than 1/4-inch, regardless of the joint width.
3. Remove the temporary masking tape immediately after tooling, and before the sealant or caulking material has taken initial set.

3.9 APPLICATION OF JOINT TREATMENT

- A. Install joint tape at all joints where gypsum boards abut and where boards form internal corners, whether or not such joints will be concealed from view.
- B. Apply compound to all joints, edges, corners, fastener head depressions and abrasions in the surfaces, whether or not such conditions will be concealed from view. Sand completely smooth all compound surfaces, which will be exposed to view, and leave ready to receive applied coatings or finish.
- C. Provide the minimum levels of gypsum board finishes as defined by the Gypsum Association recommended specifications GA-214 and GA-216, per the following:
 1. At areas hidden from view, except as otherwise specified: Level 1. At areas hidden from view, requiring a fire rating: Level 1.
 2. At concealed plenum spaces above ceilings attic spaces: Level 1.
 3. At non-occupied spaces (i.e. attics): Level 1.
 4. At areas hidden from view, corridor side of all corridor partitions: Level 1.
 5. At surfaces scheduled to receive applied acoustical wall paneling: Level 2.
 6. At surfaces scheduled to receive plastic wall panels specified under Section 09 77 63 - SANITARY WALL PANELS: Level 3.
 7. At surfaces scheduled to receive "flat" (without any sheen), "pearlescent", and egg-shell low-gloss painted finishes: Level 4.
 8. At each of the following conditions, provide Level 5 finish:
 - a. Boards having glass-fiber facing scheduled to receive a painted finish.
 - b. Surfaces subject to long dimensional runs, sun-lit and grazed lighting conditions.
 - c. Wall surfaces with a light cove at the ceiling level.
 - d. Wall surfaces that are lit with raking light or washed with lights.
 - e. Wall surfaces that are perpendicular to an exterior wall that have a window coming right up to the intersection of the interior and exterior walls.
 - f. Locations noted on Drawings.

3.10 TOLERANCES

- A. Maximum variation for gypsum board partitions and ceilings from true flatness: 1/8 inch per 10 feet, noncumulative.

3.12 CLEANING

- A. Daily clean work areas by sweeping and disposing of debris, scraps, and deposits of compound and gypsum fill.
- B. After completion of the work of this Section, remove equipment, and clean all wall, partition, and floor areas free from deposits of gypsum fill, and other materials installed under this Section.

End of Section 09 21 10

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SECTION 09 22 16 NON-STRUCTURAL METAL FRAMING**PART 1 - GENERAL**

1.1 SUMMARY

- A. The work of this Section consists of non-load bearing metal framing for partitions, ceilings, and soffits, where shown on the Drawings, as specified herein, and as required for a complete and proper installation.
- B. Furnish and install:
 - 1. Metal furring and framing where indicated on the Drawings, including cross bracing and knee bracing.
 - 2. Reinforcing plate blocking.
 - 3. Deflection track assemblies at tops of metal stud partitions.
 - a. Provide fire-rated assemblies at fire-rated, corridor, and smoke partitions.
 - b. Provide non fire-rated assemblies at all other partitions.

1.2 RELATED SECTIONS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 06 10 00 - ROUGH CARPENTRY:
 - 1. Wood blocking and framing, where indicated.
 - 2. Installation of metal door frames in gypsum board work.
- D. Section 08 11 13 - HOLLOW METAL DOORS AND FRAMES: Furnishing steel door frames.
- E. Section 08 31 00 - ACCESS DOORS AND PANELS: Shop primed access panels, occurring in partitions and walls.
- F. Section 09 21 10 - GYPSUM BOARD ASSEMBLIES: Gypsum board, applied over metal framing installed by this Section 09 22 16 including: gypsum board, and related trim components.
- G. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING: Supply and return air registers.
- H. Division 26 - ELECTRICAL: Independent hangers for suspended lighting fixtures.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL

REQUIREMENTS

1. ASTM C 645 - Non-Load Bearing Steel Studs, Runners, and Rigid Furring Channels for Screw Application of Gypsum Board.
2. ASTM C 646 - Steel Drill Screws for the Application of Gypsum Sheet Material to Light Gage Steel Studs.
3. ASTM C 754 - Installation of Steel Framing Members to Receive Screw Attached Gypsum Wallboard.
4. ASTM E 90 - Method of Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
5. ASTM E 119 - Fire Tests of Building Construction and Materials.
6. ASTM F 1267- Expanded Metal, Steel.
7. GA 203 - Installation of Screw-Type Steel Framing Members to Receive Gypsum board.

1.4 SUBMITTALS

- A. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 1. Literature: Manufacturer's product data sheets, specifications, performance data, physical properties for each item furnished hereunder.
 2. Sustainable Design Submittals:
 - a. Provide the following LEED submittal items:
 - 1) All relevant supporting documentation, as required by LEED v4 and as detailed in Section 01 81 13 - SUSTAINABLE DESIGN REQUIREMENTS.
 - 2) A completed LEED Materials Reporting Form, per Section 01 81 13 -SUSTAINABLE DESIGN REQUIREMENTS.

1.5 QUALITY ASSURANCE

- A. Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
- B. Seismic Compliance: Nonstructural components that are permanently attached to structures and their support attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance to local jurisdiction
- C. Applicator, with a minimum of 3 years documented experience demonstrating previously successful work of the type specified herein.
- D. Obtain products required for the Work of this Section from a single manufacturer.

1.6 REGULATORY REQUIREMENTS

- A. Obtain certificate of compliance from authority having jurisdiction indicating approval of specified products.
- B. Fire resistance ratings: Where gypsum board systems with fire-resistance ratings are indicated, provide materials and assemblies of the rating required, tested per ASTM E 119, which are identical to those indicated by reference to Gypsum Association file

numbers in "Fire Resistance Design Manual" or to design designation in the Underwriters Laboratories "Fire Resistance Directory" or in listing of other testing agencies acceptable to authorities having jurisdiction and to the Owners' insurance underwriters.

1. Fire-Test-Response Characteristics: Provide components that comply with rating requirements specified for fire-rated assemblies under UL 2079 for non-load bearing wall systems.
 - a. Deflection Clips and Firestop Track: Connections and/or top runner provided in fire-resistance-rated assemblies shall be certified by UL 2079 for cyclic movement requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and in manner to keep them dry, protected from weather, corrosion and damage from construction traffic and other causes.

1.8 SEQUENCING AND SCHEDULING

- A. Work of this Section shall be closely coordinated with the work of Section 09 29 00 - GYPSUM BOARD to assure the steady progress of the Contract.
- B. Coordinate the work of this Section with the respective trades responsible for installing interfacing work, and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.

1.9 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 1. Metal components and related items:
 - a. Dietrich Industries, Inc., Pittsburgh, PA.
 - b. Georgia Pacific Corporation, Gypsum Division, Atlanta, GA.
 - c. Marino Industries Corp., South Plainfield, NJ.
 - d. National Gypsum Company, Gold Bond Products Division, Charlotte, NC.
 - e. Unimast Incorporated, Franklin Park, IL.
 - f. USG Corporation, Chicago, IL.
 2. Suspended furring system for ceilings and soffits:
 - a. Armstrong World Industries, Inc., Lancaster, PA.

- b. Chicago Metallic Corporation, Chicago, IL.
 - c. USG Corporation, Chicago, IL.
- B. The design and details as shown on the drawings and the model numbers specified herein are to establish the standards of design and quality and not to limit competition.

2.2 FRAMING MATERIALS

- A. "Hat shaped" Furring channels: 7/8 x 2-3/4 inch, roll formed, hat-shaped, furring channel 22 gage hot-dip galvanized steel conforming to ASTM C 645.
- B. Studs: 'C-shaped' screw studs, hot-dip galvanized steel complying to ASTM C 645, 20 gage (0.0329 inch minimum thickness), of widths indicated on the Drawings, or other gages as required under the specified standards to meet fire resistance ratings.
- C. Runners for metal studs: 'U-shaped' hemmed, hot-dip galvanized steel track conforming to ASTM C645, of gage and width to match respective stud sizes, or heavier gage per design requirements, having 1-1/4 inch leg, provided at tops and bottoms of all studs and at heads of all openings in stud partitions.
- D. Internal reinforcement for various stud conditions, and bracing as required: 10 gage, minimum, galvanized steel.
- E. Furnish cross bracing and knee bracing, as required to assure a completely rigid assembly on metal stud partitions and furred areas.

2.3 DEFLECTION TRACK ASSEMBLIES

- A. Non Fire-Rated Assemblies
 - 1. Deflection Track: Manufacturer's standard top runner with extended flanges designed to prevent cracking of gypsum board applied to interior partitions resulting from deflection of the structure above fabricated from steel sheet complying with ASTM A 653 or ASTM A 568. Thickness as indicated for studs, and width to accommodate depth of studs, and the following configuration.
 - a. Top runner with extended deep flanges that either have V-shaped offsets that compress; slots 1 inch o.c. that allow fasteners attached to studs through the slots; or 16 gage sliding clip assemblies attached to top track and clipped to stud.
 - b. Deflection track assemblies shall allow for movement of a minimum of 1 inch.
- B. Fire-Rated Assemblies: Head of wall dynamic fire rated joint systems for head of wall assemblies in compliance with UL 2079 HW-D classified assemblies. Provide one of the following systems:
 - 1. Deflection track / clip system: The Steel Network, Inc., product "VertiClip", including step bushings. Clips and track 20 gage, and of width to accommodate depth of studs indicated.
 - 2. Deflection slip track System: Comply with requirements of ASTM C 645 except configuration, of thickness indicated for studs and width to accommodate

depth of studs indicated with flanges offset to accommodate gypsum board thickness.

- a. Fire Trak Corp., Kimball, MN products:
 - 1) "Shadowline" at balanced and unbalanced fire-rated assembly partitions.
 - 2) "Cavity Shadowline" at shaftwall and chase wall (double stud) partitions.
 - b. Deflection track assemblies shall allow for movement of a minimum of 1 inch.
3. Coordination: Verify with partition schedule on the Drawings to ensure proper depth of flange offsets at various partitions types.

2.4 CEILING AND SOFFIT SUSPENSION MATERIALS

- A. Hanger attachments: Galvanized steel hanger eyes, of size and capacity to safely sustain a live load of at least 150 pounds per hanger attachment.
- B. Hangers: Soft temper, pre-stretched galvanized carbon steel wire, conforming with ASTM A641, with a yield stress load of at least three times design load, but not less than 12 gage.
- C. Grid system for direct attachment of gypsum board: Comprised of double web main furring tees, 1 1/2 inches high by 1-3/8 inches flange face by 0.020 inch thick; double web cross tees, 1 1/2 inches high by 15/16 inch flange face by 0.020 inch thick; 0.020 inch thick wall channels, with 1 1/2 inches interior web height; and all splices, clips, and related items. Provide Underwriters Laboratories Label fire-rated assemblies for locations requiring fire-rated ceilings and soffits
 1. Chicago Metallic product "system 640 Furring System".
 2. Armstrong World Industries product "Drywall Furring System".
 3. Donn (USG) Corporation, Chicago IL., product "USG Drywall Furring System" with DGLW tees.

2.5 CEILING AND SOFFIT FRAMING MATERIALS

- A. Carrying channels, 2 inches deep, 16 gage cold-rolled channels, galvanized.
- B. Support channels: 3/4 inches deep, 16 gage cold-rolled channels, galvanized.
- C. Furring Channels: 7/8 x 2-3/4 inch, roll-formed, hat-shaped, furring channel 25 gage hot-dip galvanized steel galvanized steel conforming to ASTM C 645.
- D. Metal Studs used in ceiling framing: 'C-shaped' screw studs, hot-dip galvanized steel complying to ASTM C 645, 25 gage, of widths indicated on the Drawings, or other gages as required under the specified standards to meet fire resistance ratings.
- E. Coordination: Verify with partition schedule on the Drawings to ensure proper depth of flange offsets at various partition types.

2.6 ACCESSORIES

- A. Metal sheet plate blocking and bracing, where indicated: galvanized sheet 0.0312 inch thickness (20 gage).
- B. Fasteners:
 - 1. Expansion-type fasteners for securing vertical concrete and masonry surfaces.
 - 2. Concrete stub nails for securing runners to concrete.
 - 3. N^o.7 by 7/16 inch Pan head self-drilling screw to attach metal framing components.

PART 3 - EXECUTION

3.1 INSTALLATION, QUALITY STANDARDS

- A. General: Perform erection procedures for the various gypsum board system conditions, except as otherwise specified, as set forth in GA 201, GA 206, the written instructions of gypsum board manufacturer, together with the additional requirements specified herein and as indicated on the Drawings.
- B. Wherever fire-resistive rated assemblies are indicated on the Drawings, erect gypsum board systems in strict accordance with the manufacturers' UL listed test constructions for the required fire rating on each specific assembly.

3.2 INSTALLATION OF FURRING

- A. Install metal furring channel horizontally, with channels spaced not more than 16- inch on centers, and attaching the channels to the masonry or concrete substrates with expansion type fasteners spaced not more than 8 inches on centers. Shim beneath channels as needed to ensure that a uniform receiving plane is maintained throughout.

3.3 INSTALLATION OF PARTITION FRAMING, GENERAL

- A. Install metal runners at floor and ceiling to structural elements with suitable fasteners located 2 inches from each end and intermediate fasteners spaced no greater than 24 inches.
- B. Install metal stud framing with open side facing in same direction, engaging floor and ceiling runners.
 - 1. Stud spacing:
 - a. Typical: 16 inches on-center.
 - b. For abuse resistant gypsum board finish: 16 inches on-center.
 - c. For cement board substrate to receive tile finishes: 16 inches on-center.
 - 2. When necessary to splice studs, nest stud with 8 inch overlap and screw studs together with screws on both flanges.
 - 3. Where studs are installed directly to exterior concrete walls, provide air space as detailed on the Drawings, between stud and wall.

- C. Install studs in direct contact with all door and window frame jambs, abutting partitions, partition corners and existing construction elements; screw fasten with screw through both flanges of studs and track, top and bottom.
- D. Securely anchor studs to jamb and head anchors of steel door and interior lite frames. Over head of frames and openings in partitions, install a horizontal section of runner with a web flange bent at each end, horizontally and secure to strut studs with two screws in each bent web. Provide cripple studs over wall openings.
- E. Where horizontal studs are used for wall reinforcing or framing, cut pieces of stud and install horizontally between vertical studs. Cope horizontal studs to fit between flanges of vertical studs. Bend ends of horizontal studs or install clip angles in order to secure by screwing to vertical studs.
- F. Furnish and install additional cross bracing and knee bracing and other framing elements, as required to assure a completely rigid assembly on metal stud partitions and furred areas, whether or not such bracing has been indicated on the Drawings, and for proper receipt of items which will be attached to partition surfaces.

3.4 INSTALLATION OF DEFLECTION TRACK

- A. Isolate interior metal stud framing and shaft wall framing from building structure to prevent transfer of loading imposed by structural movement due to deflection.
 - 1. Install deflection track top runner in accordance with manufacturer's instructions and as required to attain lateral support and avoid axial loading.
 - 2. Install fire-rated deflection track top runner in accordance with manufacturer's instructions at top of fire-rated, corridor and smoke partitions.

3.5 INSTALLATION - CEILING SUSPENSION SYSTEM

- A. Coordinate layout and installation of suspension system components for suspended ceilings with other work supported by, or penetrating work of this section. Re-adjust ceiling suspension system, prior to the installation of the gypsum board and after installation of mechanical and electrical equipment and fixtures by the respective trades.
- B. Install all components of concealed grid system in accordance with the manufacturer's instructions, with current ASTM C 636 requirements, with design and installation of suspended grid system safely sustaining a membrane loading of at least 7.9 pounds per square foot.
- C. Install hangers not more than 24 inches on centers over locations of main tee members. Install hanger wires to hanger attachment with triple twists. Install additional wires as required to provide support for main tees, at intervals not exceeding four feet, wherever main tees must be interrupted in order to install other work and at all other

locations as may be directed by the Architect.

- D. Install main tees parallel to long dimension of the area, at spacing not to exceed 48 inches on-center. Secure with hanger wire as the work progresses. Install cross tees as recommended by the system manufacturer, except spacing shall not exceed 16 inches on-center.

3.6 INSTALLATION OF CEILING AND SOFFIT FRAMING

- A. Install framing to height indicated, independent of walls, columns, and above ceiling work. Erect after Work above ceiling is complete. Coordinate the location of hangers with other work.
- B. Securely anchor hangers to structural members or embed in structural slab. Space hangers to achieve deflection limits indicated.
- C. Space main carrying channels at maximum 48 inch centers; not more than 4 inches from wall surfaces. Lap splice securely.
- D. Securely fix furring channels or metal studs to hangers to prevent turning or twisting and to transmitted full load to hangers.
 - 1. Place furring channels perpendicular to carrying channels at 16 inches on center, not more 1 inch from perimeter walls and rigidly secure. Lap splice securely.
 - 2. Screw fasten metal studs perpendicular to carrying channels at 16 inches on center, not more 1 inch from perimeter walls. Lap splice securely.
- E. Reinforce openings in suspension system which interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 24 inches past each opening.

3.7 TOLERANCES

- A. Install partition and ceiling framing and furring with a maximum variation from true flatness of 1/8 inch per 10 feet, non-cumulative.

END OF SECTION 09 22 16

SECTION 09 51 00 ACOUSTICAL CEILINGS**PART 1 – GENERAL**

1.1 SUMMARY

- A. The work of this Section consists of acoustical tile where shown on the Drawings, as specified herein, and as required for a complete and proper installation. Work includes but is not limited to the following.
- B. Furnish and install the following:
 - 1. Suspended acoustical tile ceiling including suspension system and associated edge moldings.
 - 2. Suspended acoustical clouds including suspension system and associated edge moldings.
 - 3. Furnish and install joint sealant at ceiling edge angles where abutting walls.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 08 31 13 - ACCESS DOORS AND PANELS, and by trades requiring the same: Shop primed access panels, occurring in partitions and walls.
- D. Section 09 22 16 - NON-STRUCTURAL METAL FRAMING: Metal ceiling and soffit framing for gypsum board, including hanger attachments, wire hangers, and screwable metal tee grid system.
- E. Section 09 21 10 - GYPSUM BOARD ASSEMBLIES: Suspended drywall construction ceilings and soffits.
- F. Division 21 – FIRE PROTECTION: Sprinkler heads in ceiling system.
- G. Division 23 - MECHANICAL: Air diffusion devices in ceiling.
- H. Division 26 - ELECTRICAL:
 - 1. Fire alarm and smoke detection equipment mounted in ceiling system.
 - 2. Light fixtures and independent hangers for suspended fixtures.

1.3 REFERENCES

- A. Referenced Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. The standards referenced herein are included to establish recognized minimum quality only. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.
1. ASTM A 641 - Zinc- Coated (Galvanized) Carbon Steel Wire
 2. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method "UL Classified".
 3. ASTM C 523 - Light reflectance of Acoustical Material by the Integrating Sphere Reflectometer.
 4. ASTM C 635 - Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
 5. ASTM C 636 - Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
 6. ASTM E 84 - Surface Burning Characteristics of Building Material "UL Classified"
 7. ASTM E 119 - Fire Tests of Building Construction and Materials "UL Classified".
 8. ASTM E 413 - Classification for Rating Sound Insulation.
 9. ASTM E 580 - Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint.
 10. ASTM E 1264 - Classification of Acoustical Ceiling Products.
 11. ASTM E 1414 - Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum. "UL Classified".
 12. UL Fire Resistance Directory and Building Material Directory.
 13. All applicable federal, state and municipal codes, laws and regulations regarding flammability and smoke generation of interior finishes.
- B. General References The following reference materials are hereby made a part of this Section by reference thereto:
1. CISCA (Ceilings and Interior Systems Contractors Association) - Acoustical Ceilings: Use and Practice.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work of this Section with the respective trades responsible for installing interfacing and adjoining work for proper sequence of installation, and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.

- B. Sequencing:
 - 1. Field Measurements:
 - a. Take field measurements before preparation of shop drawings and fabrication, where possible, to ensure proper fitting of Work.
 - b. Allow for adjustments within specified tolerances wherever taking of field measurements before fabrication might delay Work.
 - 2. Coordinate the work of this Section with the respective trades responsible for installing interfacing work, to allow work which will be concealed by the ceilings to be completed prior to commencing installing the ceilings in such locations.
- C. Scheduling:
 - 1. Install acoustical units after interior wet work is dry.
 - 2. Schedule 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.

1.5 SUBMITTALS

- A. Information and Review Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 - 1. Product Data: Manufacturer's product data sheets, specifications, performance data, physical properties for each item furnished hereunder.
 - 2. Shop Drawings:
 - a. 1/4 inch scale plans of each room or space; indicate grid layout and related dimensioning, junctions with other work or ceiling finishes, interrelation of mechanical and electrical items related to the system.
 - b. All drawings bearing dimensions of actual measurements taken at the project.
 - c. Large scale installation details of special conditions.
 - 3. Verification Samples:
 - a. Full size samples of acoustical units, illustrating material and finish.
 - b. 12 inch long samples of suspension system components including main runners, cross runner and edge trim.
 - c. 12 inch long samples of existing exposed spline suspension system components including runners and edge trim for comparison with supplied materials.
 - d.
- B. Closeout Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS.

1. Bonds and Warranty Documentation:
 - a. Manufacturer's Warranties and guarantees as specified elsewhere herein this Section.
 - C. Maintenance Material Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS. Clearly label and package extra materials securely to prevent damage.
 1. Provide to the Owner, extra ceiling panel and suspension components, 5 percent of each type installed.
- 1.6 QUALITY ASSURANCE
- A. General: Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
 - B. Sole Source: Obtain products required for the Work of this Section from a single manufacturer, or from manufacturers recommended by the prime manufacturer of acoustical ceiling panels.
- 1.7 MOCK-UPS
- A. Locate mock-ups where directed and include all surfaces and materials scheduled to receive a field applied finish.
 - B. Maintain mock-up during construction for workmanship comparison; remove and legally dispose of mock-up when no longer required.
 - C. Accepted mock-ups may not remain as part of the work; the number of mock-ups shall not be restricted.
- 1.8 DELIVERY, STORAGE AND HANDLING
- A. Delivery and Acceptance Requirements:
 1. Do not deliver items to the site, until all specified submittals have been submitted to, and approved by, the Architect.
 2. Do not deliver acoustical ceiling panels to the project until all concrete, masonry, plaster and other wet work has been completed and dry.
 3. Deliver acoustical ceiling panels in original, unopened packages and store protected in a fully enclosed space.
 - B. Storage and Handling Requirements:
 1. Protect materials from damage due to moisture, direct sunlight, excessive temperatures, surface contamination, corrosion and damage from construction operations and other causes.

- C. Packaging Waste Management:
- D. Damaged material: Remove any damaged or contaminated materials from job site immediately, including materials in broken packages, packages containing water marks, or show other evidence of damage, unless Architect specifically authorizes correction thereof and usage on project.

1.9 SITE CONDITIONS

- A. Maintain uniform temperature of minimum of 60 degrees Fahrenheit and humidity of 20 to 40 percent prior to, during, and after installation.

1.10 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.
- B. Manufacturer Warranty:
 - 1. In addition to the specific guarantee requirements of the GENERAL CONDITIONS and SUPPLEMENTAL GENERAL CONDITIONS, the Contractor shall obtain in the Owner's name the standard written manufacturer's guarantee of all materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 - 1. Acoustical ceiling panel:
 - a. Armstrong World Industries, Inc., Lancaster, PA.
 - b. USG Interiors Inc., Chicago, IL.
 - c. Certainteed Corporation, Valley Forge, PA.
 - 2. Suspension system:
 - a. Armstrong World Industries, Inc., Lancaster, PA.
 - b. USG Interiors Inc., (Donn®) Chicago, IL.
 - c. Chicago Metallic Corp., Chicago, IL.

2.2 DESCRIPTION

- A. General Description: Manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance as indicated.
 - 1. Obtain certificate of compliance from authority having jurisdiction indicating approval of specified products.

2.3 PERFORMANCE/DESIGN CRITERIA

- A. Fire Resistance: Where fire-resistance ratings are indicated or required by authorities having jurisdiction, provide materials and construction which are identical to assemblies whose fire-resistance ratings have been tested in compliance with ASTM E 119 by independent agencies acceptable to the Architect and authorities having jurisdiction.
- B. Surface Burning Characteristics: Provide UL Classified material whose surface burning characteristics, when tested in compliance with ASTM E 84 are Class A.
- C. Where the following ratings are specified, provide materials and construction which are identical to those tested by Underwriters Laboratories or equivalent independent testing agencies acceptable to the Architect.
 - 1. Noise Reduction Coefficient (NRC): Ratings have been tested in compliance with ASTM C423.
 - 2. Ceiling Attenuation Class (CAC) : Ratings have been tested in accordance with ASTM E1414.
 - 3. Light Reflectance (LR): Ratings has been tested in compliance with ASTM C523.

2.4 ACOUSTICAL CEILING PANELS

- A. Type ACT-1 ceiling panels:
 - 1. Panel size: 24 inches by 24 inches by $\frac{3}{4}$ inch thick.
 - 2. Panel edge: Lay-in.
 - 3. Description: ASTM E-1264 Type IV, Form 2, Pattern E, Class A flamespread, wet formed mineral fiber with acoustically transparent membrane, non- combustible, vinyl latex paint finish.
 - 4. Color: Black.
 - 5. Minimum light reflectance range: N/A
 - 6. Acoustical characteristics:
 - a. NRC range: .75

- b. CAC range: 30
 - 7. Acceptable products:
 - a. Armstrong product "Backstage Noir".
 - b. CertainTeed product "Theatre Black F".
- B. Type ACT-2 ceiling panels:
 - 1. Panel size: 24 inches by 24 inches by $\frac{3}{4}$ inch thick.
 - 2. Panel edge: Tegular edge.
 - 3. Description: ASTM E-1264 Type IV, Form 2, Pattern E, Class A flamespread, wet formed mineral fiber with acoustically transparent membrane, non-combustible, vinyl latex paint finish.
 - 4. Color: White.
 - 5. Minimum light reflectance range: LR 0.90
 - 6. Acoustical characteristics:
 - a. NRC range: .70
 - b. CAC range: 35
 - 7. Acceptable products:
 - a. Armstrong product "Ultima, Tegular" product number 1914.
 - b. CertainTeed product "Symphony M" product number 1220BB-IOF-1.
 - c. USG product "Mars ClimaPlus" with SLT edge, product number 88785.

2.5 CEILING GRIDS

- A. Types GRID-1 and GRID-2 ceiling grids: 15/16 inch exposed tee grid in white color or black color matching ceiling panel. Acceptable products include the following, or approved equal:
 - 1. Armstrong; 15/16" Prelude Exposed Tee System.
 - 2. Chicago Metallic; 200 Snap-Grid System.
 - 3. Donn; DX Series.
 - 4. Celotex, 15/16" Release System.

2.6 CEILING GRID PERIMETER EDGE TRIM SYSTEM

- A. Perimeter edge trim system at "Floating" suspended ceiling areas. Edge trim shall be designed to accommodate straight edges. Attachment to grid system is provided by a specially designed attachment clip, which snaps into the locks against hems of trim and is screw-attached to the bulb of the intersection suspension system member. Independent sections of trim are joined together using the splice plate. Acceptable products are:

1. Armstrong: Axiom Perimeter Trim.
 2. Chicago Metallic: Infinity suspension trim.
 3. USG: Compasso series.
- B. Color: white color (Type TRIM-1) or black color (Type TRIM-2) matching ceiling panel and grid.

2.7 ACCESSORIES

- A. Acoustical infill panels:
1. Acoustical treatment: Bio-acoustical infill panel, black faced glass fiber installed above ceiling.
 - a. NRC: 0.75
 2. Armstrong: Model 5479 or approved equal.
- B. Edge/wall moldings where ceiling abuts walls and drop down soffits: Stepped profile shadow molding compatible with exposed grid system and color matched.
1. Armstrong: Model 7878 or approved equal.
- C. Edge/wall moldings where ceiling abuts walls and drop down soffits: Stepped profile reveal shadow molding compatible with exposed grid system and color matched.
1. Armstrong: Model 7902 or approved equal.
- D. Hanger attachments: Of the most appropriate types for the specific receiving surfaces.
- E. Hanger rods: Black finished hanger ½ inch diameter threaded rods at ACT-4 location.
- F. Hangers: ASTM A641 Soft temper, pre-stretched galvanized carbon steel wire, with a yield stress of at least 3 times design load, but not less than 12 gage.
- G. Joint Sealer: One component acrylic latex, permanently elastic, non-staining, non-shrinking, non-migrating and paintable.
1. Tremco, Beachwood OH.; product, "Acoustical Sealant".
 2. United States Gypsum Company, Chicago IL.; product "USG Acoustical Sealant".
 3. Pecora Corporation, Harleysville PA.; product " AC-20 FTR".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Inspect all surfaces and verify that they are in proper condition to receive the work of this Section.
 - 1. Beginning of installation means acceptance of existing substrate and project conditions.

3.2 PREPARATION

- A. Protection of In-situ Conditions: During the operation of work of this Section, protect surrounding materials and finishes against undue soilage and damage by the exercise of reasonable care and precautions. Clean, or repair all existing surfaces which are soiled or otherwise damaged by Work of this Section, to match indicated profiles and specified finishes. Materials and finishes which cannot be cleaned, or repaired shall be removed and replaced with new work in conformance with the Contract Documents.
- B. Surface Preparation:
 - 1. Carefully examine all receiving surfaces, to which attachments will be made hereunder, and determine the most practical way of making such attachments. Request Architect's approval of any attachment method which differs from that indicated on the approved shop drawings before proceeding with installation.
 - 2. Permit acoustical ceiling tile to reach room temperature and a stabilized moisture content prior to installation.

3.3 INSTALLATION

- A. Locate system on room axis, leaving equal sized border units of not less than one-half tile width.
- B. Install all components of the suspended grid systems in accordance with the manufacturer's instructions, the approved shop drawings, conforming to ASTM C- 636 requirements. Ensure a deflection not to exceed 1/360 span of 48-inch simple span.
- C. Install specified edge moldings wherever ceilings intersect a wall or partition surface, and around all items having any dimension of 4 inches or more which penetrate the ceilings, including circular penetrations. Set moldings absolutely level, using as long lengths as practicable, and secure with fasteners recommended by manufacturer for the type of substrate.
 - 1. Sealant Bed: Apply continuous ribbon of acoustical sealant, concealed on back of vertical leg before installing moldings.
 - 2. Screw-attach moldings to substrate at intervals not over 16 inches on center. and not more than 3 inches from ends, leveling with ceiling suspension system to tolerance of 1/8 inch in 12'-0". Miter corners accurately and connect securely.
- D. Install hanger attachments to overhead construction in accordance with the approved shop drawings, spacing the attachments not more than 48 inches on

centers over location of each main tee member.

1. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers to span the extra distance.
 2. Install hanger wire to attachments with triple twists.
- E. Install main tees parallel to the long dimension of each area, spacing the tees 48 inches on centers. Secure the bottom of hanger wires through slots in the main tee members and tie with triple twists. Level the main tees as the work progresses.
- F. Lateral bracing:
1. Provide lateral bracing as required by applicable codes and regulations.
 2. Secure lateral bracing to structural members as detailed on the Drawings.
- G. Uniformly space the cross tees at 24 inches on centers, and secure the cross tees into the main tees as recommended by the system manufacturer.
- H. Provide sealant at gaps between new acoustical ceiling edge angles and all irregular walls.
- I. Fit acoustical ceiling tile units in place, free from damaged edges or other defects detrimental to appearance and function. Install acoustical ceiling tile level, in uniform plane, and free from twist, warp or dents.
1. Field cut tegular type tile with a tegular reveal at all edge conditions.
 2. Where required by governmental agencies having jurisdiction, install retention clips, provide two clips per ceiling panel installed on opposite sides of panel.

3.4 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.

3.5 CLEANING

- A. Properly clean surfaces of panels and open grids free from dirt and handling marks. Wherever surfaces cannot be cleaned by normal methods or have defects, remove and replace with new components.
- B. Upon completion of the work of this Section in any given area, remove tools, equipment and all rubbish and debris from the work area; leave area in broom-clean condition.
- C. Clean work under provisions of Division 01 – GENERAL REQUIREMENTS.

3.6 PROTECTION

- A. Protect finished work under provisions of Division 01 – GENERAL REQUIREMENTS.

End of Section 09 51 23

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SECTION 09 65 10 - RESILIENT FLOORING AND ACCESSORIES**PART 1 - GENERAL**

1.1 SUMMARY

- A. Prepare substrate to receive resilient base.
- B. Furnish and install the following:
 - 1. Resilient base at resilient flooring and at sealed exposed concrete floors.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling
- C. Division 01 - GENERAL REQUIREMENTS: Procedural and administrative requirements for construction and demolition recycling.
- D. Section 09 68 13 - TILE CARPETING: Carpeting and transition strips.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 - GENERAL REQUIREMENTS. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. ASTM E 84 - Surface Burning Characteristics of Building Materials.
 - 2. ASTM F 1861 - Standard Specification for Resilient Wall Base
 - 3. All applicable federal, state and municipal codes, laws and regulations regarding flammability and smoke generation of interior finishes.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. General: Coordinate the work of this Section with the respective trades responsible for installing interfacing and adjoining work for proper sequence of installation and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.

1.5 SUBMITTALS

- A. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 - 1. Literature: Manufacturer's product data sheets, specifications, performance data, physical properties and installation instructions.
- B. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 - 1. Literature: Manufacturer's product data sheets, specifications, performance data, physical properties and installation instructions.
 - 2. Selection samples: Manufacturers' sample chain of colors available for selection by Architect.
 - 3. Verification samples: Each type resilient base and color selected, 24 inches long.

1.6 QUALITY ASSURANCE

- A. General: Avoid color and pattern differential; provide base from one production run in any single room or contiguous areas.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Do not deliver items to the site, until all specified submittals have been submitted to, and approved by, the Architect.
 - 2. Deliver resilient base materials in original, unopened packages and store protected for three days prior to installation in area of installation to achieve temperature stability.
- B. Storage and Handling Requirements:
 - 1. Store materials in a clean dry, enclosed space off the ground and protected from the weather. Protect adhesives from freezing.

1.8 SITE CONDITIONS

Maintain uniform temperature of minimum of 65 degrees Fahrenheit and humidity of 20 to 40 percent 48 hours prior to, during, and 48 hours after installation. Store resilient flooring materials and accessories in the spaces where they will be installed for at least 48 hours before beginning installation. Thereafter, maintain a minimum temperature of 55 degrees Fahrenheit in the areas where the work is completed.

1.1 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.
- B. Manufacturer Warranty:

1. Resilient Base: Provide manufacturer's standard one year limited product warranty for resilient base materials.
2. Adhesives: Provide manufacturer's one year limited product warranty for adhesion reliability.

1.2 EXTRA MATERIALS

- A. Upon completion of the Work of this Section, deliver to the Owner extra base materials for future repairs and maintenance, from the same manufacturing runs as those installed, in the following amounts.
 1. Resilient base: 10 percent of each type, color and quantity installed.

PART 2 - PRODUCTS

1.3 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 1. Johnsonite, Middlefield OH.
 2. Burke-Mercer Products Company, San Jose CA.
 3. Roppe Corporation, Fostoria OH.
 4. Vinyl Products Inc., Floor Products Division, Sheboygan WI.
 5. Tarkett, Inc., Parsippany NH.

1.4 RESILIENT BASE

- A. Rubber Base: 4 inches high as scheduled, ribbed back, 1/8 inch thick, rounded top complying with ASTM F-1861, Type TP, Thermoplastic Rubber (TBR). Colors shall be as selected. Rubber base shall be furnished in continuous lengths, approximately 100 feet long.
 1. Basis of Design
 - a. Manufacturer: Roppe. Type "Contours # Simplicity - PV4000"
 - b. Color: Charcoal

1.5 ACCESSORIES

- A. Adhesives:
 1. General: Water resistant, low VOC, acceptable to the resilient flooring manufacturer, for substrate conditions.
 2. Acceptable products include the following, or approved equal:
 - a. Advanced Adhesive Technology, Inc, Dalton GA, product: "No. 432 Modified Acrylic Cove Base Adhesive".

- b. DAP Incorporated, Dayton OH, product: "Cove Base Construction Adhesive".
- B. Joint Sealer for between the top of wall base and irregular wall surfaces: Plastic filler as recommended by manufacturer.
- C. Cleaning material: Domestic neutral floor detergent having a pH 7 or pH 8, as recommended by the flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect all surfaces and verify that they are in proper condition to receive the work of this Section.
- 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 resilient base.
- C. Beginning of installation means acceptance of existing substrate and site conditions.

3.2 INSTALLATION

- A. Install all products in strict accordance with each manufacturer's written installation procedures and other provisions specified herein.
- B. Spread only enough adhesive to permit installation of materials before initial set.
- C. Install resilient base: Install base on solid backing, bond to vertical substrate with continuous contact at horizontal and vertical surfaces. Apply wall base to walls, columns, casework and other permanent fixtures in areas where base is required.
 - 1. Install in lengths as long as practical.
 - 2. Scribe to fit to door frames and other interruptions.
 - 3. Scribe level to fit below ceramic wall tile.
 - 4. Form all external and internal corners in accordance with manufacturer's written instructions. Cope inside corners and fit neatly.
 - 5. Fill voids with plastic filler along the top edge of the resilient wall base on masonry surfaces or other similar irregular substrates.

3.3 CLEANING

- A. Post-installation Cleaning: As installation progresses, continually remove excess adhesive from floor, base and wall surfaces without damage.

End of Section 09 65 10

SECTION 09 68 13 TILE CARPETING**PART 1 - GENERAL**

1.1 SUMMARY

- A. Furnish and install carpet tile directly adhered over floors, where indicated on the Drawings, including all accessories necessary to complete the work.
- B. Furnish and install flocked textile flooring tile directly adhered over floors, where indicated on the Drawings, including all accessories necessary to complete the work.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 02 41 19 - SELECTIVE DEMOLITION: Removal of existing flooring finishes.
- D. Section 09 65 10 - RESILIENT FLOORING AND ACCESSORIES: Straight resilient bases, where indicated in conjunction with carpeting.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. ASTM D 2859 - Test Method for Flammability of Finished Textile Floor Covering Materials.
 - 2. ASTM E 84 - Surface Burning Characteristics of Building Materials.
 - 3. ASTM E 648 - Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.
 - 4. NFPA: Publication 253 - Test for Critical Radiant Flux of Floor Covering Systems.
 - 5. All applicable federal, state and municipal codes, laws and regulations regarding flammability and smoke generation of interior finishes.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. General: Coordinate the work of this Section with the respective trades responsible for installing interfacing and adjoining work for proper sequence of installation, and ensure that the work performed hereunder is acceptable to such

trades for the installation of their work.

- B. Sequencing:
 - 1. Sequence work to ensure resilient flooring is not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, wet work is dry and cured, and work overhead is completed.
 - 2. Ensure that installation of flooring and accessories occurs after other finishing operations and interior wet work is complete and fully cured, including painting.

1.5 SUBMITTALS

- A. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 - 1. Literature: Manufacturer's product data sheets, specifications, performance data, physical properties, for each item furnished hereunder, including carpet, accessories, adhesives, and leveling materials.
 - 2. Manufacturer's installation instructions: Provide manufacturer's application methods or installation instructions for each item furnished hereunder. Indicate special procedures, and perimeter conditions requiring special attention.
 - 3. Manufacturer's sample warranties.
 - 4. Manufacturer's certificate: Provide certificate stating that the carpet, and other related materials to be supplied hereunder meet all requirements specified herein.
 - a. Submit certification from the fiber producer verifying use of the branded fiber in the submitted carpet product.
 - 5. Shop drawings: 1/8 inch scale plans of all carpeted areas indicating direction of carpet, location of seams and method of joining seams.
 - a. Show location of different patterns or styles of carpet.
 - 6. Selection samples:
 - a. Sample swatches containing manufacturer's full color and blend range.
 - b. Vinyl edge strip sample illustrating manufacturer's full color range.
 - 7. Verification samples:
 - a. 12 inch long samples of edge strip.
 - b. After initial selection of carpet and color blends has been made by the Architect: 18 inches by 27 inches sample of selected carpet for final approval of the Architect. Approved samples shall be used as the standard of quality and colors for materials furnished under this Contract.
- B. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS.
 - 1. Maintenance Data: Prior to Project Substantial Completion, deliver to the Architect copies of the carpet manufacturer's detailed maintenance recommendations for the care cleaning and stain-removal, and repair of the types of carpets installed. Include product data and Material Safety Data Sheets (MSDS) for cleaning materials.

- C. Maintenance Material Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS. Clearly label and package extra materials securely to prevent damage.
 - 1. Extra Materials: Upon completion of the Work of this Section, Deliver to the Owner extra materials for future repairs and maintenance. Clearly label and package securely to prevent damage.
 - a. Owner's carpet tile stock: An amount equal to 3 percent of each color, pattern and type of carpet installed.
- 1.6 QUALITY ASSURANCE
- A. Applicator: Company specializing in carpet installation of the type specified herein with a minimum of three years documented experience.
- 1.7 MOCK-UPS
- A. Provide mock-up under provisions of Division 01 –GENERAL REQUIREMENTS.
 - B. Provide mock-up sample of one area to be designated by Architect, demonstrating the minimum quality of installation for the Work.
 - C. Locate mock-ups where directed and include all surfaces scheduled to receive a carpeted finish.
 - D. Maintain mock-up during construction for workmanship comparison; remove and legally dispose of mock-up when no longer required.
 - E. Accepted mock-ups may remain as part of the work; the number of mock-ups shall not be restricted.
- 1.8 ENVIRONMENTAL CONDITIONS
- A. Do not install carpet until areas have been fully enclosed and environmental conditions have reached the levels indicated during occupancy.
 - B. Store materials for 3 days (72 hours) prior to installation in area of installation to achieve temperature and humidity stability. Carpet and adhesive must be stored at a minimum temperature of 68 degrees F.
 - C. Maintain a temperature of at least 60 degrees Fahrenheit, with a relative humidity of between 15 and 60 percent, for a period of 72 hours before, during, and after installation.
 - D. Ventilate spaces where work of this Section occurs, during and for a period of 72 hours after completion of carpet installation. Ventilate to dissipate humidity, and to prevent accumulation of fumes, vapors, and gases. Provide temporary fan units and ducting as required for venting operations
- 1.9 DELIVERY, STORAGE, AND HANDLING
- A. Store all carpeting material under cover in dry, well-ventilated spaces as soon as

delivered. Protect carpeting from damage, dirt, stain, moisture, and mildew.

1.10 WARRANTY

- A. Furnish the following warranties under provisions of Division 01 – GENERAL REQUIREMENTS:
1. Furnish carpet installer's written guarantee covering prompt and proper replacement of any and all carpeting which indicates improper installation workmanship and/or defective material within twelve months from completion of the installation and acceptance thereof by the Architect, said corrective work being performed by the Carpet installer at no cost to the Owner.
 2. Furnish carpet manufacturer's warranty which shall contain the following:
 - a. Commencement date for warranty: Date of Project Substantial Completion.
 - b. Wear Warranty - Lifetime of Carpet. No more than 10% face yarn loss by weight in normal use.
 - c. Static Warranty - Lifetime of Carpet.
 - d. Edge Ravel Warranty - Lifetime of Carpet. Guaranteed no edge ravel in normal use (no seam sealers required).
 - e. Delamination Warranty - Lifetime of Carpet. Guaranteed no delamination in normal use (no chair pads required).
 - f. Tuft Bind Warranty - Lifetime of Carpet. Guaranteed not to zipper, wet or dry.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. General requirements: Carpet tiles, shall conform with or pass tests of the following Standards:
1. ASTM D-2859 (Methenamine Reagent Pill Test).
 2. ASTM E-648 (Flooring Radiant Panel Test): Class I (Minimum Average CRF of 0.48).
 3. NBS Smoke Chamber Test: Maximum average of 450.
 4. AATCC-134 (Electrostatic Propensity): Maximum electrostatic generation below level of human sensitivity.

2.2 FLOCKED TEXTILE FLOOR TILE

- A. Flocked tile: To establish a standard of quality, design and function desired, specifications have been based on Forbo, product "Flotex", modular flocked tile, size 9 1/2 by 40 inches.
1. Refer to Materials List and finish plans for colors and textures.

2.3 ACCESSORIES

- A. Transition strips, carpet reducers, edgings and accessories: Homogeneous vinyl, in colors as selected by the Architect.
 - 1. Transition strips: Equal to Roppe Corporation, model #159" reducer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Inspect all surfaces and verify that they are in proper condition to receive the work of this Section.
 - 1. Ensure that newly placed concrete has cured for a minimum period of 30 days and that moisture content of concrete is within range specified by adhesive manufacturer.
 - 2. Verify concrete substrate has been cured and is sufficiently dry to achieve a bond with the adhesive, in accordance with the manufacturer's recommended bond and moisture test.
 - a. Insure that concrete substrate has a moisture content of not more than 3.5 percent by weight. Perform moisture test in several locations using carbide method dampness meter.
 - 3. Verify that surfaces are smooth and flat with a maximum variation of 1/4 inch in 10 feet, and are ready to receive work.
 - 4. Request correction of defects in receiving surfaces which are not correctable by the methods specified herein. Do not commence work until such defects are entirely corrected
 - 5. Beginning of installation means acceptance of existing substrate and site conditions.

3.2 PREPARATION

- A. Surface Preparation:
 - 1. Remove by mechanical means (light sanding and grinding), all protruding edges, high spots. Ensure that substrate is free from paint, varnish, wax, oil, existing adhesive residue, or other foreign matter. Do not use solvents.
 - 2. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler. Apply, trowel and float finish subfloor filler and leave a smooth, level, hard surface. Prohibit traffic from area until filler is cured.
 - 3. Apply troweled subfloor filler and leveler to provide finished concrete surface smooth, with no more than 1/8 inch variation from plane within 10 feet in any direction.
 - a. Prohibit traffic until filler and leveler is cured.
 - 4. Vacuum clean substrate, and ensure that substrate is dry, clean and smooth prior to application of flooring.
- B. Preheat areas to receive carpet to a minimum temperature of 60 degrees F for 72 hours prior to installation, with a relative humidity between 15 and 60 percent.

Maintain minimum temperature of 60 degrees F thereafter.

- C. Measure all areas to receive materials to be furnished and installed hereunder, and verify in the field their actual dimensions, including wall-to-wall dimensions, offsets, door locations, and details, fixed equipment, and all other installed items. Extra charges will not be allowed because of lack of familiarity with actual project conditions. Small pieces of carpet will not be acceptable.

3.3 INSTALLATION

- A. Install carpet tile in accordance with carpet and adhesive manufacturers' instructions. Immediately notify Architect of conflicts. Cement carpet directly to the substrate with specified installation adhesive. Trowel adhesive evenly on the substrate. Install the carpet within thirty minutes after spreading adhesive.
- B. Lay carpet tile in a square grid pattern, with joints and seams parallel to building lines. Lay joints straight and continuous in both directions and with border carpet tile not less than 1/2 the width of the tile.
 - 1. Install carpet tile using quarter-turn method as recommended by manufacturer.
- C. Install specified edging wherever carpeting abuts a dissimilar flooring material, except where wood thresholds, or resilient floor tile trim occurs.

3.4 CLEANING

- A. Daily clean work areas by disposing of carpet scraps. After completion of the work of this Section, remove equipment, and clean all wall, partition, and floor areas free from deposits of adhesives and other materials installed under this Section.
- B. Clean and vacuum carpet surfaces upon completion of the installation.

3.5 PROTECTION

- A. Prohibit traffic from carpet areas for 24 hours after installation.
- B. Protect carpet against damage during construction. Cover with not less than 6-mil thick polyethylene covering with taped joints during construction period whenever protection is required, so that carpet will be without any indication of deterioration, wear, or damage at time of completion.
- C. Maintain protection of carpeting on each floor or area until work is accepted.

End of Section 09 68 13

SECTION 09 84 00 ACOUSTICAL TREATMENTS**PART 1 - GENERAL**

1.1 SUMMARY

- A. Acoustical Wall Treatments
 - 1. Type WC-1 – Two layer Semi-rigid Polyester Panel Color A
 - 2. Type WC-2 – Two layer Semi-rigid Polyester Panel Color B
- B. Installation of the items specified herein.

1.2 RELATED REQUIREMENTS

- A. Division 01 – GENERAL REQUIREMENTS: Procedural and administrative requirements for construction and demolition recycling.
- B. Section 09 21 10 GYPSUM BOARD ASSEMBLIES

1.3 SUBMITTALS

- A. Product Literature for each panel type.
- B. Shop drawings based on configuration/layout shown on interior elevations.
 - 1. Include existing benches and ceilings in the shop drawings.
 - 2. Verify existing conditions in field.
- C. Full range of color samples for initial color selection.
- D. Two sets of 12"x12" samples for verification.

1.4 REGULATORY REQUIREMENTS

1.5 QUALITY ASSURANCE

- A. Coordinate with LED letter signage

1.6 DELIVERY, STORAGE AND HANDLING

- A. Store all materials in original packaging in protected interior location.

1.8 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:

1. Acoufelt
2. EzoBoard
3. Zintra

2.2 PRODUCTS

- A. WC-1/WC-2 Semi rigid polyester panel
1. Semi rigid panels fabricated from 100% thermally bonded high-density polyester
 2. No less than 60% recycled material
 3. 1/2" Thickness (2-layers)
 4. Minimum NRC: 0.45
 5. Fire Rating
 - ASTM E84-15a: Class A, FS:0 – SD:65
 - Group 1 per AS ISO 9705-2003
 6. VOC Emissions
 - Low VOC product per ASTM D5116
 - VOC concentration: 0,009 mg/m3 (7 days)
 7. Impact Resistance
 - ISO 7892:1988
 8. Panel size: refer to Interior Elevations.
 9. Fabricated from P.E.T. (10%-30%) and Recycled Cotton (70%-90%)
 10. Edge Style: Straight
 11. Panel size: refer to Interior Elevations.
- B. Basis of Design
1. Manufacturer: Acoufelt. "Fracture Two-Tone"
 - Pattern: "Barcode"

2.3 COLOR

- A. Basis of Design Product colors:
 - 1. Type WC-1
 - Face: Slate
 - Back: Metal
 - 2. Type WC-1
 - Piano Black
 - Back: Metal

- B. To verified. Selected from manufacturer's full range of colors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. All surfaces must be clean, dust-free and dry as dust and moisture will adversely affect the adhesive and may result in lack of adhesion.
- B. Ensure that the substrates, backgrounds and adjoining surfaces will allow work to reach the required standard.

3.2 STORAGE

- A. Handle panels with care and store in a dry indoor space. Protect edges from being crushed.

3.3 INSTALLATION

- A. Install panels per manufacturer's recommendations.
- B. Coordinate with LED letter signage for sequencing and installation.
- C. Use Low VOC adhesives.

3.4 CLEANING

- A. Clean surfaces and edges to be free from residual glues or installation marks.

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End of Section 09 84 00

SECTION 09 90 00 PAINTING AND COATINGS**PART 1 - GENERAL**

1.1 SUMMARY

- A. Summary: This Section consists of painting work where shown on the Drawings, as specified herein, and as required for a complete and proper installation. Painting work includes, but is not limited to the surface preparation and application of coated finishes, and subsequent touch-up, of interior and exterior items and surfaces as indicated on the Contract Drawings and as scheduled herein.
1. No attempt is made in this Section to list all surfaces, fixtures and equipment requiring painting on this project. It is the responsibility of the Trade Contractor to determine for itself the scope and nature of the Work required for a complete installation from the information provided herein and in the Drawings.
 2. Exposed Surfaces:
 - a. Where item or surface is not specifically mentioned, paint same as similar adjacent materials or surfaces.
 - b. If color or finish is not designated, Architect will select from standard colors or finishes available.
 - c. All partitions in the classrooms shall be painted.
- B. Surfaces and Materials: In general, without limiting the generality thereof, the following new and existing surfaces, fixtures and equipment require a painted finish:
1. Gypsum board partition and wall surfaces, ceilings and soffits.
 2. Masonry walls and partitions.
 3. Metal and wood doors and frames.
 4. Wood trim not scheduled for shop finishing.
 5. Window interiors.
 6. Ceiling plenum above linear ceiling systems including but not limited to walls, underside of slab, structural beams and columns, mechanical electrical and plumbing devices, piping, ductwork, and suspension systems.
 7. Exposed to view ductwork.
 8. Exposed to view structural steel.
 9. Exposed to view sprinkler piping.
 10. Exposed to view electrical conduit and raceways.
 11. Exposed to view portions of ducts, (interior side) at diffusers.
 12. Access panels and frames.
 13. Historic plaster trim, molding and ornamental detailing.

- D. DO NOT PAINT the following surfaces and materials.
1. Concealed from view surfaces, except as indicated otherwise in the Contract Documents or as specified herein.
 2. Chrome or nickel plating, stainless steel, bronze, brass.
 3. Aluminum other than mill finished or factory primed. Factory finished mechanical and electrical equipment, pumps, machinery and similar items which occur in mechanical, storage or equipment rooms or areas.
 4. Factory finished materials, specialties, and accessories unless otherwise specified.
 5. Ceramic tile, resilient flooring, and other integrally finished floor, wall and ceiling finishes.
 6. Prefinished millwork items.
 7. Audio visual cabling systems.
 8. Fire resistant testing and certification labels, code required labels, safety warning labels, performance rating plates, nomenclature plates, identification plates, and similar other labels.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 05 50 00 - METAL FABRICATIONS: Shop priming of designated miscellaneous metals.
- D. Section 08 11 13 - HOLLOW METAL DOORS AND FRAMES: Shop priming of metal frames and steel doors.
- E. Section 08 31 00 - ACCESS DOORS AND PANELS: Shop primed access panels, occurring in partitions and walls.
- F. Section 09 21 10 - GYPSUM BOARD ASSEMBLIES: Drywall partitions, ceilings and soffits, including joint treatment and sanding.
- G. Document 09 91 23 - INTERIOR PAINTING SCHEDULE:
1. Painting schedule for interior surfaces and materials.
 2. Painting schedule for Mechanical and Electrical Equipment.
- H. Section 10 44 00 - FIRE PROTECTION SPECIALTIES: Shop priming of cabinet doors and frames; shop finishing of cabinet.
- I. Division 26 - ELECTRICAL: Prefinished items such as light fixtures, switch gear, electrical distribution cabinets and similar surfaces and materials.

- J. Respective sections: Factory-finishing of mechanical, plumbing, fire protection and electrical equipment.

1.3 REFERENCES

- A. Referenced Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. The standards referenced herein are included to establish recognized minimum quality only. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.

1. ANSI/ASTM D 16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
2. ASTM D 2016 - Test Method for Moisture Content of Wood.
3. All applicable federal, state and municipal codes, laws and regulations for flammability and smoke generation of interior finishes.

- B. Definitions:

1. "Paint" includes coating systems materials, primers, emulsions, enamels, stains, sealers and fillers, and other applied materials specified herein, whether used as prime, intermediate or finish coats.
2. Sheen: Specular gloss readings in accordance with ASTM D52.
 - a. Flat: less than 5 (measured at 85 degrees).
 - b. Eggshell: 5 – 20 (measured at 60 degrees).
 - c. Satin: 15-35 (measured at 60 degrees).
 - d. Low Luster: 25 – 35 (measured at 60 degrees).
 - e. Semi-Gloss: 30 -65 (measured at 60 degrees).
 - f. Gloss: 65 or more (measured at 60 degrees).
3. Gloss as defined for VOC requirements. Specified specular gloss readings below are as tested in accordance with ASTM D52.
 - a. Flat: less than 15 (measured at 85 degrees), less than 5 (measured at 60 degrees).
 - b. Non-Flat: greater than 15 (measured at 85 degrees), greater than 5 (measured at 60 degrees).

1.4 SUBMITTALS

- A. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 1. Literature: Manufacturer's product data sheets, specifications, performance data, physical properties, material compositions, and application instructions for all finishing products to be applied hereunder.
 - a. Include certification of data indicating Volatile Organic Compound (VOC) content of all paint materials.

2. Samples:
 - a. Manufacturer's color selector for custom mixed colors for Architect's color scheduling.
 - b. Opaque coatings: Two 9 x 12 inch finished samples on hardboard of each color scheduled in each finish for review and approval. Identify boards with finish type, color mix number and scheduled substrate surfaces or materials.
 3. Sustainable Design Submittals:
 - a. Provide the following LEED submittal items:
 - 1) All relevant supporting documentation, as required by LEED v4 and as detailed in Section 01 81 13 - SUSTAINABLE DESIGN REQUIREMENTS.
 - 2) A completed LEED Materials Reporting Form, per Section 01 81 13 -SUSTAINABLE DESIGN REQUIREMENTS.
- B. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
1. Color chips: After final approval of all colors and tints by the Architect, submit to the Owner, color chips of all coatings used, with manufacturer's name and mix designation of the coating for the purpose of future re-ordering of coatings. Color chips shall be at least six (6) square inches in size, for each color and tint.
- C. Maintenance Material Submittals: Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS. Clearly label and package extra materials securely to prevent damage.
1. Extra Stock Materials: Provide extra materials equal to 10% of installed coatings in containers for all paints and finishes installed. Provide to the Owner extra stock of each color and finish scheduled herein. Label each container with paint mix number, and identify locations where color and tint was used.

1.5 QUALITY ASSURANCE

- A. Single source responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.
- B. Environmental Requirements for Volatile Chemicals:
1. For interior applications use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA method 24) and the following chemical restrictions:
 - a. Flat Paints and Coatings: VOC not more than 50 g/L.
 - b. Non-Flat Paints and Coatings: VOC not more than 150 g/L.
 - c. Anti-Corrosive Coatings: VOC not more than 250 g/L.
 - d. Floor coatings: VOC not more than 100 g/L
 - e. Sealers:
 - 1) Waterproofing sealers: VOC not more than 250 g/L.

- 2) Sanding sealers: VOC not more than 275 g/L.
 - 3) All other sealers: VOC not more than 200 g/L.
 - f. Stains: VOC not more than 250 g/L.
2. Do not use water based paints formulated with aromatic hydrocarbons (organic solvent with a benzene ring in its molecular structure), formaldehyde, halogenated solvents, mercury or mercury compounds, or tinted with pigments of lead, cadmium, chromium VI and their oxides. Water based paints shall be low VOC and shall have a flash point of 61 degrees C or greater.
 3. Where it is necessary to use solvent-based paints, with less than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 4. The following shall be low VOC and not be formulated with aromatic hydrocarbons (organic solvent with a benzene ring in its molecular structure).
 - a. High performance water based acrylic coatings.
 - b. Pigmented acrylic sealers.
 - c. Catalyzed epoxy coatings.
 - d. High performance silicone grafted epoxy coatings.

1.6 FIELD SAMPLES

- A. Paint on-site sample areas, minimum 40 square feet, illustrating selected color, and tint.
- B. Locate samples where directed. The Contractor shall provide in the base Contract, a total amount of samples equal to one sample per room.
- C. Accepted samples may not remain as part of the work.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site in sealed and labeled containers; container labeling shall include manufacturer's name, type of paint, color mix designation, expected coverage, surface preparation instructions, instructions for mixing and reducing, drying time, and clean-up recommendations.
- B. Store materials, conforming with applicable codes and fire regulations, in designated spaces. Keep storage area secure when direct access is not required or when not performing work under this Section. Take precautionary measures to prevent fire hazards and spontaneous combustion, maintain a dry-chemical type fire extinguisher in all areas where materials of this Section are being stored or used.
- C. Store paint materials in a well ventilated area at minimum ambient temperature of 45 degrees Fahrenheit and a maximum of 90 degrees Fahrenheit.
- D. Do not use the sanitary system for mixing or disposal of refuse material. Carry water to mixing rooms and dump waste material in a suitable refuse receptacle.

Remove oily rags and waste each day.

1.8 PROJECT CONDITIONS

- A. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45 degrees Fahrenheit for 24 hours before, during and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is above 50 percent unless required otherwise by manufacturer's instructions.
- C. Apply paints and finishes above minimum temperature conditions in strict accordance with manufacturer's instructions.
- D. Provide sufficient lighting to maintain 80 foot-candles measured mid-height at substrate surface.

1.9 SEQUENCING AND SCHEDULING

- A. The applicator of work specified herein is responsible to ensure that all paints, enamels, and coatings, proposed to be applied hereunder, are compatible with coatings used for shop-primed items and items which have been prime-coated under the work of other trades.
- B. Immediately notify the Architect in writing of conditions which may require a change in the specifications of this Section before proceeding with the work. Failure to do so, in a timely fashion, so as not to interfere with the schedule of work of this Contract, shall be construed as acceptance of the coatings specified. Perform all corrective measures, at no cost to the Owner, for any defects in the work, resulting from the use of such materials.
- C. Painting work should be scheduled so as to minimize touch-ups. Interior painting is to be without flashmarks. Should flashmarks occur due to touch-ups, the Contractor shall be required to redo the entire surrounding wall surface.

1.10 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 - 1. Paints and general finishes:

- a. Benjamin Moore & Company, Montvale, NJ.
 - b. California Paints, Andover MA.
 - c. Glidden Professional / PPG Industries, Inc, LLC, Strongsville, OH.
 - d. Devoe High Performance Coatings / PPG Industries, Inc, LLC, Strongsville, OH.
 - e. Pittsburgh Paints / PPG Industries, Inc., Pittsburgh PA.
 - f. Pratt & Lambert Inc., Buffalo, NY.
 - g. Sherwin Williams, Cleveland OH.
2. Cold galvanizing touch-up paint:
 - a. ZRC Worldwide Inc., Marshfield MA.
 - b. Duncan Galvanizing, Malden Ma.
 - c. Rustoleum Corp., Vernon Hills IL.
 3. Caulking
 - a. Pecora Corporation, Harleysville PA.
 - b. Sonneborn Building Products Inc., Minneapolis MN.
 - c. Tremco, Beachwood OH.

2.2 MATERIALS

- A. Coatings: Ready mixed, except for field catalyzed coatings with good flow and brushing properties; capable of drying or curing free of streaks or sags. Color pigments shall be processed to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating. Provide best quality grade, where manufacturer makes more than one grade of any material specified.
- B. Liquid zinc coating, for touch-up of welds, scratches, and abrasions in galvanized steel: Low VOC organic zinc-rich coating containing 92% metallic zinc, by weight in the dried film (ASTM D520, Type III) and conforming to SSPC Paint 20, Type II, Level 1. Liquid zinc coating shall be recognized under the Component Program of Underwriter's Laboratories, Inc. as an equivalent to hot-dip galvanizing; conforming to MIL-P-21035B and SSPC Paint 29, Type II, Level I, for repair of hot-dip galvanizing and meeting the requirements for Zinc-Rich Paints.
 1. VOC limit: not more than 250 g/L.
 2. Specified manufacturer and product: ZRC Worldwide, Marshfield MA, product "ZRC-221".
- C. Filler for repair of minor cracks in gypsum wallboard prior to painting: One component acrylic latex caulking compound, conforming to FS 19-TP-21M and ASTM C 834, paintable within 24 hours after application, with a minimum movement capability of ± 12.5 percent, equal to one of the following:
 1. Pecora, product "AC-20+".
 2. Sonneborn Building Products Inc., product, "Sonolac".
 3. Tremco, product, "Trimflex 834".

2.3 ACCESSORIES

- A. Accessory materials: other materials not specifically indicated, but are required to achieve the finishes specified of commercial quality.
- B. Cleaning Materials:
 - 1. Tri-Sodium Phosphate (TSP) substitute products:
 - a. Savogran, Norwood MA, products "TSP-PF", or "Liquid TSP Substitute".
 - b. Custom Building Products, Seal Beach, CA., product "Custom T.S.P. Substitute".
 - c. DAP Inc., Baltimore MD., product "T.S.P. Substitute Heavy Duty Cleaner".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect all surfaces and verify that they are in proper condition to receive the work of this Section. Notify Contractor of any condition that may potentially affect proper application of coatings.
- B. Measure moisture content of surfaces, do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum board and joint treatment: 12 percent.
 - 2. Masonry or concrete: 12 percent.
- C. Beginning Work of this Section means acceptance of substrate surfaces and site conditions.

3.2 PREPARATION

- A. Furnish and lay suitable drop cloths in all areas where coating work is being done to protect floors and all other surfaces from damage during the work. Protect adjoining surfaces with painters mask tape.
- B. Prior to preparing surfaces or finishing, remove all finish hardware for painting doors and frames, except hinges and locks on exterior door; remove electrical plates, light fixture trim and fittings. Re-install hardware and other removed items after painted surfaces are thoroughly dry.
- C. Mix coatings thoroughly, unless otherwise directed by the manufacturer of the specific coating used, to ensure uniformity of color and mass. Strain previously opened coatings to remove skins, lumps, and other foreign matter prior to painting.
- D. Thin or reduce materials only as recommended by the specific material manufacturer, and only with the approval of the Architect.
- E. Impervious surfaces: Remove mildew by scrubbing with solution of tri-sodium

phosphate and bleach. Rinse with clean water and allow surface to thoroughly dry.

- F. Concrete and unit masonry surfaces scheduled to receive paint finish:
 - 1. Remove all loose scale and mortar, dirt, salt or alkali powder and other surface contaminants, using a detergent expressly formulated for cleaning of concrete and masonry.
 - 2. Remove oil and grease with a solution of tri-sodium phosphate.
 - 3. Remove stains caused by weathering corroding metals with a solution of sodium metasilicate after thoroughly wetting with water.
 - 4. Thoroughly rinse the cleaned surfaces with clear water, and allow the surfaces to completely dry, allow a minimum of 4 hours before commencing application of coatings.

- G. Uncoated steel and iron surfaces:
 - 1. Remove grease, scale, dirt, rust, and all foreign materials, down to bright metal by wire brushing, scraping, sanding, or sandblasting where heavy coatings of scale are evident.
 - 2. Wash steel with solvent, apply a treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned.
 - 3. Spot prime after repairs with metal primer product of the finish coating manufacturer.

- H. Shop primed steel surfaces:
 - 1. Remove rust, blistered and defective shop prime paint, and all foreign materials, down to bright metal by wire brushing, scraping, sanding, or commercial paint remover. Feather edges to make touch-up patches inconspicuous.
 - 2. Remove all grease or dirt with mineral spirits.
 - 3. Spot prime bare metal with metal primer product of the finish coating manufacturer. Seal top and bottom edges of metals doors with primer.

- I. New galvanized surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

- J. Aluminum surfaces scheduled for paint finish:
 - 1. Remove surface contamination by steam or high pressure water.
 - 2. Remove oxidation with acid etch and solvent washing.
 - 3. Apply etching primer immediately following cleaning.

- K. Gypsum board surfaces: Fill minor defects with latex based spackle. Spot-seal all compound surfaces and repair areas in gypsum board, with specified first coat material before application of the first coat.

3.3 APPLICATION

- A. Apply all materials in strict accordance with the approved manufacturer's printed instruction, and in accordance with the best trade practices. Each coat shall be reviewed and approved by the Architect before succeeding coats are applied.
- B. Do not apply successive coating until the preceding coat is thoroughly dry, and in no case in less than 24 hours after the preceding coat.
- C. Number of coats is indicated under Painting Schedules. Number of coats is indicated as a minimum number to be applied over scheduled substrates. An additional coat or coats may be required for proper color coverage of substrate as determined by the Architect, at no additional cost to the Owner. Examples of these conditions include, but are not limited to:
 - 1. Dark colored substrates may require an additional primer or intermediate coat to stabilize color, if final applied top-coat color is light.
 - 2. Pre-finished or pre-primed products may require an additional field applied coat to stabilize the shop/factory applied base color prior to application of top- coat finishes.
 - 3. ark color top coat finishes may require additional finish coat over white or light colored substrates to obtain correct color density.
- D. Apply each coat to a uniform finish; Apply primer and first coat of slightly lighter in color tint than the scheduled color of the final coat.
- E. Sand lightly between coats to achieve required finish and remove sanding dust prior to applying succeeding coat.
- F. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

3.4 APPLICATION – CONCRETE MASONRY

- A. Apply epoxy block filler to concrete masonry partitions at maximum rate allowed by coating manufacturer. Apply by airless spray followed by back rolling to force material into voids. Use a squeegee to remove excess material prior to initial set, and provide a smooth surface texture. After initial set, touch-up and fill apparent voids and holidays with fresh material.

3.5 CLEANING

- A. Upon completion of the work in each area, remove all coating splatters from glass, prefinished surfaces, bright metals, and from other surfaces that have not been painted or finished hereunder. Do not use abrasive paper or abrasive cleaner on any prefinished surface or bright metal. Remove all materials and debris; leave work area in a clean condition.

3.6 PROTECTION AND TOUCH-UP

- A. During painting work, protect the work of other trades against undue soilage and damage by the exercise of reasonable care and precautions. Properly clean, repair or

replace any work so damaged and soiled.

- B. Protect all painted and finished surfaces against damage until the date of final acceptance of the work. The Architect will conduct a final review of all work performed hereunder. Re-coat or touch-up, all scratches and other blemishes on surfaces, and as directed by the Architect, any areas found which do not comply with the requirements of this Section, and bear all costs therefore.
- C. Any re-coating or touch-up work, required after the work of this Section has been reviewed and accepted by the Architect, will be paid for by the Contractor.

3.7 PAINTING SCHEDULE

- A. Colors: The Architect will furnish a schedule of colors for each area and surface. Tinting and matching shall be to the satisfaction of the Architect. No limit is placed on the number of colors that may be required, or the number of colors in any one room, area, or surface. Premium paints of deep-hued, bright, pigment intensive, accent and primary colors may be scheduled for up to 25 percent of all interior and exterior surfaces without additional cost to the Owner.
 - 1. Colors of priming coats (and body coats where specified) shall be lighter in tint than those of finish coat.
 - 2. Colorants: Pure, non-fading pigments, mildew-proof, ultra-violet resistant, finely ground in approved medium; and be limeproof, when used in coatings to be applied on masonry, concrete, plaster, and gypsum board surfaces.
- B. Paint schedule for exterior surfaces and materials: Refer to Document 09 91 13.
- C. Paint schedule for interior surfaces and materials: Refer to Document 09 91 23.
- D. Paint schedule for labeling and identifying fire resistive and rated designations: Refer to Document 09 91 23.
- E. Painting schedule for mechanical and electrical equipment: Refer to Document 09 91 23.

End of Section 09 90 00

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DOCUMENT 09 91 23 - INTERIOR PAINTING SCHEDULE**PART 1 - GENERAL**

1.1 GENERAL PROVISIONS

- A. General: Number of coats scheduled herein below is minimum required, refer to Article entitled "APPLICATION" in specification Section 09 91 00 - PAINTING, regarding coverage.

1.2 PAINTING SCHEDULE FOR INTERIOR SURFACES AND MATERIALS

A. Interior CONCRETE walls and partitions:

1. One coat acrylic primer.
 - a. California: "Prime Choice 100% Acrylic Universal Primer", N°. 50600.
 - b. Moore: "Ultra Spec Masonry Acrylic Sealer 608.
 - c. PPG: "Perma-Crete Acrylic Alkali Resistant Primer", N°. 4-603.
 - d. Sherwin-Williams: "Lox-On Interior Acrylic Masonry Primer" A24W8300 Series.
2. Two coats acrylic semi-gloss paint:
 - a. California: "Fres-Coat Unite 100% Acrylic Latex Semi-Gloss", N°. 563.
 - b. Moore: "Ultra Spec 500 Semi Gloss N539.
 - c. PPG: "Speedhide", 6-500 Series.
 - d. Sherwin-Williams: "ProMar 200 Latex Semi-Gloss".

B. Interior CONCRETE MASONRY walls and partitions:

1. One coat block filler:
 - a. California: "Mason-Cote 100% Acrylic Latex Block Filler", N°. 3751.
 - b. Moore: "Ultra Spec Masonry Acrylic Sealer 608
 - c. PPG: "Speedhide Interior Masonry Latex Block Filler", 6-7 Series.
 - d. Sherwin-Williams: "PrepRite Int. Ext Block Filler", B25-W25 Series.
2. Two coats acrylic semi-gloss paint:
 - a. California: "Fres-Coat Unite 100% Acrylic Latex Semi-Gloss", N°. 563.
 - b. Moore: "Ultra Spec 500 Semi Gloss N539.
 - c. PPG: "Speedhide", 6-500 Series.
 - d. Sherwin-Williams: "ProMar 200 Latex Semi-Gloss".

- C. Interior EXPOSED DUCTWORK, Insulated.
 - 1. Apply one prime coat and two finish coats of a paint recommended by the approved paint manufacturer for application on the exposed wrapping material.

- D. Interior GYPSUM BOARD partitions:
 - 1. One coat latex primer.
 - a. California: "Elements 100% Acrylic White Primer", N°. 74600.
 - b. Moore: "Ultra Spec 500 Interior Latex Primer", N°. N534.
 - c. PPG: "Pure Performance Interior Latex Primer", N°. 9-900.
 - d. Sherwin-Williams: "Harmony Interior Latex Primer", B11W900 Series.
 - 2. Two coats eggshell paint:
 - a. California: "Elements 100% Acrylic Zero VOC Eggshell", N°. 731.
 - b. Moore: "Ultra Spec 500 Low Sheen Eggshell N537.
 - c. PPG: "Pure Performance Eggshell", N°. 9-300.
 - d. Sherwin-Williams: "Harmony Low Odor Interior Latex Eg-Shel", B9 Series".

- E. Interior GYPSUM BOARD ceilings and underside of soffits:
 - 1. One coat latex primer.
 - a. California: ""Elements 100% Acrylic White Primer", N°. 74600".
 - b. Moore: "Ultra Spec 500 Primer N534.
 - c. PPG: "Pure Performance Interior Latex Primer", N°. 9-900.
 - d. Sherwin-Williams: "Harmony Interior Latex Primer", B11W900 Series.
 - 2. Two coats flat paint
 - a. California: "Elements Zero VOC Flat 100% Acrylic", N°. 733".
 - b. Moore: "Ultra Spec 500 Latex Flat N536.
 - c. PPG: "Pure Performance, Flat", 9-100Series.
 - d. Sherwin-Williams: "Harmony Low Odor Interior Latex Flat", B5 Series.

- F. Interior METAL, FERROUS, excluding railings, to receive semi-gloss finish:
(includes galvanized metal doors and frames):

1. One coat of rust prohibitive primer for unfinished metal surfaces, and touch up bare metal at shop primed, existing and previously coated surfaces:
 - a. California: "Rust-Stop DTM Primer/Finish", N°. 1061.
 - b. Moore: "Acrylic Metal Primer", N°. P04.
 - c. PPG: "Pitt-Tech DTM Primer/Finish 100% Acrylic", 90-709/712 Series
 - d. Sherwin-Williams: "DTM Acrylic Primer Finish", B66 W1 Series.
 2. Two coats acrylic semi-gloss enamel:
 - a. California: "Rust-Stop DTM Primer/Finish", N°. 1061.
 - b. Moore: "Ultra Spec 500 DTM Acrylic Semi-Gloss", N°. HP29.
 - c. PPG: "Pitt-Tech Plus High Performance, Semi -Gloss DTM Industrial Enamel", 90-1210 Series.
 - d. Sherwin-Williams: "Sher-Cryl HPA Semi-Gloss", B66 Series.
- G. Interior METAL, GALVANIZED, (includes exposed ductwork):
1. Touch-up with metal primer.
 - a. California: "Rust-Stop DTM Primer/Finish", N°. 1061.
 - b. Moore: "Acrylic Metal Primer", N°. P04.
 - c. PPG: "Pitt-Tech DTM Primer/Finish 100% Acrylic", 90-709/712 Series.
 - d. Sherwin-Williams: "DTM Acrylic Primer Finish" B66 W1 Series.
 2. Two coats acrylic semi-gloss enamel:
 - a. California: "Rust-Stop DTM Primer/Finish", N°. 1061.
 - b. Moore: "Ultra Spec 500 DTM Acrylic Semi-Gloss", N°. HP29.
 - c. PPG: "Pitt-Tech Plus High Performance, Semi -Gloss DTM Industrial Enamel", 90-1210 Series.
 - d. Sherwin-Williams: "Sher-Cryl HPA Semi-Gloss", B66 Series.
- H. Interior exposed METAL, PIPING: Same as specified for ferrous metal.
- I. Interior METAL, RAILINGS (handrails and guardrails):
1. One coat of epoxy primer (dry film coat 3.0 to 4.0 mils)
 - a. Moore: "Coronado Rust Scat Acrylic Primer 36.
 - b. PPG: "Aquapon WB Epoxy Primer", 98 Series
 - c. Sherwin-Williams: "Pro Industrial Pro-Cryl Universal Primer", B66-310 Series.

2. Two coats of gloss finish epoxy coating (dry film coat 2.5 to 3.0 mils).
 - a. Moore: "Corotech Water-Based Epoxy", V450 Series.
 - b. PPG: "Aquapon WB Epoxy Coatings", 98 Series. Sherwin-Williams: "Pro Industrial Waterbased Epoxy, B70W211/B60V15 Series".

1.3 PAINTING SCHEDULE FOR FIRE RESISTIVE AND RATED DESIGNATIONS

- A. In compliance with Massachusetts State Building Code and as additionally specified herein, provide identification for all fire walls, fire barriers, fire partitions, smoke barriers and smoke partitions and any other wall or partition which is required to have protected openings or penetrations.
 1. Application:
 - a. Apply to outside of fire rated shafts, and to both sides of partitions at intervals not to exceed 30'-0" for entire length of partition or wall, or once on any partition 30'-0 feet or less in length.
 - b. Locate identification in all accessible concealed floor, floor-ceiling and attic spaces. Locate identification within 12 to 18 inches above finished ceilings.
 - c. Apply stenciled lettering by spray or brush, or provide permanent signage. Identification shall be waterproof, fade-proof and non-combustible. Signage shall be mechanically fastened or permanently adhered to partition.
 - d. Stencil character height: 1 inch minimum.
 - e. Color: Easily identifiable color, contrasting with background, acceptable to Owner.
 2. Apply stenciled lettering to the following types of partitions using wording specified:
 - a. Applied identification for 2 hour fire rated partitions shall read: "2 HOUR FIRE WALL - PROTECT ALL OPENINGS".
 - b. Applied identification for 1 hour fire rated partitions shall read: "1 HOUR FIRE WALL - PROTECT ALL OPENINGS".

1.4 PAINTING SCHEDULE FOR MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Paint interior surfaces of air ducts, and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black enamel.

- B. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
- C. Remove unfinished louvers, grilles, covers and access panels on and paint as scheduled above. Plywood backboards for electrical panels and other equipment. Paint both front and back surfaces and all edges of plywood backboards before backboards are installed.
 - 1. One coat latex primer-sealer (undercoater):
 - a. Moore: "Ultra Spec 500 Latex Primer N534.
 - b. PPG: "Pure Performance Interior Latex Primer".
 - c. Sherwin-Williams: "Harmony Interior Latex Primer" B11W900.
 - 2. Two coats latex semi-gloss paint:
 - a. Moore: "Ultra Spec 500 Semi Gloss N539.
 - b. PPG: "Pure Performance Interior Semi-gloss", 9-500 Series.
 - c. Sherwin-Williams: "Harmony Interior Latex Semi-gloss" B10 Series.
- D. Prime and paint insulated and exposed cold pipes, conduit, electrical boxes, insulated and exposed ducts, hangers, brackets, collars and supports, except where items are located in storage, mechanical or equipment spaces or those items which are factory prefinished.
- E. Exposed to view un-insulated hot pipes within finished painted areas: Two coats heat-resistant enamel conforming to Federal Specification TT-E-496, Type I, applied when surfaces are less than 140 degrees Fahrenheit.

END OF DOCUMENT 09 91 23

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SECTION 10 11 00 VISUAL DISPLAY SURFACES**PART 1 - GENERAL**

1.1 SUMMARY

- A. Furnish and install the following:
 - 1. Framed markerboards.
 - 2. Frameless tackboards.
 - 3. Trim and accessories.

1.2 RELATED SECTIONS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 06 10 00 - ROUGH CARPENTRY: Wood blocking and plywoodsheathing.
- D. Section 09 22 16 - NON-STRUCTURAL METAL FRAMING: Reinforcing plate blocking.
- E. Section 09 21 10 - GYPSUM BOARD ASSEMBLIES: Gypsum board substrate.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Section 01 42 00 - REFERENCES.
 - 1. ASTM A 424 - Steel Sheets for Porcelain Enameling.
 - 2. ASTM B 209 - Aluminum-Alloy Sheet and Plate.
 - 3. ASTM E 84 - Standard Test Method for Surface Burning Characteristics for Building Materials.
 - 4. ASTM B 221 - Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wires, Profiles and Tubes.
 - 5. PEI - Performance Specifications for Porcelain Enamel Chalkboards.

1.4 SUBMITTALS

- A. Submit the following under provisions of Division 01 - GENERAL REQUIREMENTS:
 - 1. Literature: Manufacturer's product data sheets for each item furnished hereunder.
 - 2. Shop drawings:
 - a. 1/2 inch scale dimensioned elevations of each visual display surface condition showing layout of units.
 - b. Large scale design details of showing attachment clips and brackets; trim details and panel joint conditions and complete installation details.

- c. Coordinate required cut outs for monitor supports.
3. Selection samples: Manufacturer's sample chain showing finishes and colors available, for markerboards, tackboards and trim for selection by Architect.
4. Provide maintenance information on regular cleaning and stain removal for marker boards.

1.5 QUALITY ASSURANCE

- A. Contractor is fully responsible for proper handling during demolition and salvage, temporary storage and re-installation of chalkboards. Broken or otherwise damaged chalkboards shall be replaced in like units to match existing.

1.6 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.
- B. Provide manufacturer's standard 5 year warranty which shall include coverage of dry-marker board and porcelain enamel chalkboard surfaces from discoloration due to cleaning.

1.7 MAINTENANCE

- A. Provide maintenance information on regular cleaning, stain removal for dry-marker boards and chalk boards.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design (Specified Manufacturer): To establish a standard of quality, design and function desired, Drawings and specifications have been based on Claridge Products & Equipment Inc., Harrison AR, Product: "Series 5."
- B. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 1. Claridge Products & Equipment Inc., Harrison AR.
 2. AARCO Products, Inc., Yaphank NY.
 3. EverWhite Corp. Menomonee Falls, WI.
 4. Ghent Corporation, Lebanon OH.
 5. Marsh Industries, Inc., New Philadelphia, OH.

2.2 MARKERBOARD

- A. Aluminum framed dry markerboards of sizes indicated on Drawings.
 - 1. Exposed trim: Extruded 6063-T5 alloy aluminum, anodized, satin finished, with 5/8 inch exposed face.
- B. Markerboard surfaces:
 - 1. Porcelain enamel writing surface, equal to Claridge LCS-II and Greengard Certified.
 - a. Bottom ground coat: 1.5 to 2.2 mils.
 - b. Top ground coat: 2.0 to 2.8 mils.
 - c. Color coat: 3.0 to 4.0 mils.
 - 2. Face sheet: Low-gloss white finish equal to Claridge No. 75.
 - 3. Core material for laminated construction: 7/16 inch fiberboard core.
 - 4. Backing sheet: steel sheet or aluminum, minimum 0.015 inch thick.

2.3 ACCESSORIES

- A. Provide sliding aluminum accessories, hook type, to fit display rail.
 - 1. Marker caddy: Equal to Claridge product: "M-MC2P".
 - 2. Magnetic eraser: Equal to Claridge product: "MGM-MC1".
 - 3. Dry erase kit: Equal to Claridge product: "LCS668-4".
- B. Provide instructions for dry-marker board cleaning on metal plate attached to perimeter frame near marker tray.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Beginning of installation means acceptance of existing substrate.
- B. Verify that interior moisture and temperature approximate normal occupied conditions.
- C. Verify that internal wall blocking or reinforcing plate blocking is ready to receive work of this Section.
- D. Verify that wall surfaces are true and plumb and are prepared and ready to receive boards.

3.2 INSTALLATION

- A. Install marker boards in accordance with manufacturer's instructions. Protect porcelain enamel facing from chipping and damage during handling and installation. Install units level and plumb utilizing concealed continuous hangers wherever possible and where fasteners must be exposed, use tamperproof-type fasteners.
- B. Establish top of units to align with top of adjacent door frames, or as otherwise indicated on the Drawings.
- C. Coordinate and provide cut-outs for monitor supports.

END OF SECTION 10 11 00

SECTION 10 14 00 SIGNAGE**PART 1 - GENERAL**

1.1 SUMMARY

- A. Furnish and install the following informational and directional signage:
 - 1. Interior signage:
 - a. Primary signage: Photopolymer AAB-compliant room signage adhered with double sided acrylic foam tape, (all permanent spaces) with removable name holder slot; 0.16 inch thick, with backed acrylic polyurethane enamel paint, and raised Braille cells.
 - b. Scope includes new room signage for 101, 102, and 102A.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.

1.3 REFERENCES

- A. Referenced Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. The standards referenced herein are included to establish recognized minimum quality only. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.
 - 1. All applicable federal, state and municipal codes, laws and regulations regarding accessibility requirements.
- B. Inclusionary References: The following reference materials are hereby made a part of this Section by reference thereto:
 - 1. ANSI A 117.1 - Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
 - 2. ADAAG: Americans with Disabilities Act Accessibility Guidelines.

1.4 SUBMITTALS

- A. Submit the following under provisions of Division 01 – GENERAL REQUIREMENTS:
 - 1. Literature: Manufacturer's product data sheets, specifications, physical properties for each item furnished hereunder.
 - 2. Schedule: Prepare and issue a schedule for all identification devices to be furnished hereunder, including character types, and colors. Comply with all Rhode Island College requirements. After receipt of the Architect's schedule,

prepare and submit shop drawings and verification schedule.

3. Shop drawings:
 - a. Plan drawing showing location of each interior and exterior sign. Coordinate plan with schedule.
 - b. Elevation drawings showing full size elevations of each sign. Indicate for each sign: sign styles, lettering and locations, and overall dimensions.
 - c. Large scale design details of signs, showing attachment clips and brackets; and complete installation details.
4. Selection samples:
 - a. Sample plastic chips indicating Manufacturer's full range of colors available for initial selection by Architect.
5. Verification samples:
 - a. Full size sample sign, of type, style and color specified including method of attachment.
 - b. Full size sign in specified finish and typeface. Approved sample may be used in finished Project.

1.5 REGULATORY REQUIREMENTS

- A. Provide all signage as required by accessibility regulations and requirements of authorities having jurisdiction.
 1. Comply with all applicable federal, state and municipal codes, laws and regulations regarding signage for exits and handicapped barriers.

1.6 QUALITY ASSURANCE

- A. General: Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.
- B. Drawings and Signage Design: The Contract Drawings are for purpose to show design intent only. The Contractor is responsible for the proper engineering of all signage and support. Signage, lettering, graphics, fasteners and support items for all signs required for the Project shall be indicated in the approved shop drawings.
- C. Sole Source: Obtain products required for the Work of this Section from a single signage fabricator, or from manufacturers recommended by the prime signage fabricator of plastic plate signage.
- D. Qualifications:
 1. Signage Fabricator: Minimum of 5 years documented experience demonstrating previously successful work of the type specified herein.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivered packaged signs, labeled in name groups.
- B. Store all materials in an elevated dry location, protected by waterproof coverings. Store adhesive tape at ambient room temperature.

1.8 ENVIRONMENTAL CONDITIONS

- A. Do not install adhesive applied signs when ambient temperature is below 70 degrees Fahrenheit. Maintain this minimum during and after installation of signs.

1.9 WARRANTIES

- A. General: Submit warranties under provisions of Division 01 – GENERAL REQUIREMENTS.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 - 1. Interior plaque signs:
 - a. Basis of Design: Advance Corporation, Cottage Grove, MN.
 - b. Apco New England, Franklin, MA.
 - c. Design Communications, Boston, MA.
 - d. Sunshine Sign, North Grafton, MA.
 - e. General Sign Company, Norwood, MA.
 - f. Back Bay Sign Company, Somerville, MA.
 - 2. Individual letter signage:
 - a. ARK Ramos, Oklahoma City OK.
 - b. Gemini Inc., Cannon Falls MN
 - c. Matthews International Corporation, Pittsburgh PA
 - d. Metal Arts, Mandan

2.2 GENERAL

- A. General: Provide sign copy to match the existing signage, for sizes, styles, spacing, content, positions, materials, finishes and colors of letters.
 - 1. All Signs shall conform to United States "*Americans with Disabilities Act*" and applicable State of Rhode Island codes and regulations.
 - 2. Final placing and sizing of lettering shall be done as part of the shop drawing approval process, at which time the manufacturer shall make recommendations for Architect's review. Lettering shall have stroke width to height ratio and width

to height ratio in accordance with the Americans with Disabilities Act.

- B. Installation of all signs shall be done by vandal-proof method, fully described on the shop drawings.

2.3 DIE-CUT VINYL SIGNAGE - INTERIOR

- A. Die-cut letters: 2 Signs of equal size, with 1-1/2 inch high letters in Rhode Island College standards font. One sign shall read: "EMERGENCY EXIT ONLY" and the other: "ALARM WILL SOUND".
 - 1. Die-cut copy characters, reverse reading, from opaque non-reflective white vinyl film, 0.0035" min. thickness letters: with pressure sensitive adhesive backing, suitable for interior applications. Apply copy to the back face of 1/8- inch thick, transparent, colorless, matte finish, acrylic sheet and mount signs to finished door.
 - 2. Mount signs to inside face of door with brass round head screws.

2.4 CAST METAL LETTERS

- A. Cast aluminum letters: Projecting individual lighted cast aluminum letters.
 - 1. 4" height, 1" deep
 - 2. Brushed Silver finish.
 - 3. Translucent Lexan back for RGB LED Back-lit illumination.
 - 4. Include power supplies and studs/spacers for hanging.
 - 5. Quantity: 20 letters
 - 6. Basis of Design manufacturer: Impact Signs, LaGrange, IL
 - 7. Cast aluminum shall be solid aluminum, no scrap permitted. Cast aluminum shall be free of all porosity, with sharp corners, flat and accurate profiles. All exposed welds shall be filed smooth with all tool marks removed by fine abrasive grain air blasting or other approved method. All burrs and rough spots shall be removed and faces shall be polished to a uniform high luster finish. Aluminum shall be mechanically sanded and degreased prior to receiving finish. All coatings shall be true to form with no irregularities.

2.5 ACCESSORIES

- A. Exposed mounting hardware: Chrome plated brass or bronze screws.
- B. Adhesive tape: Double sided acrylic foam tape, permanent adhesive, equal to 3M, St. Paul, MN., product: "3M VHB".
- C. Fasteners for entrance and exit signs: Concealed metal fasteners, non-corrosive to sign material or mounting surface.

- D. Anchors and inserts for cast aluminum letters:
 - 1. Aluminum collars, matte finished to match letter edges.
 - 2. Mounting studs: Threaded type 304 stainless steel studs.
 - 3. Fasteners for interior brass plate signage: N°. 6 brass wood screws, round head.

2.6 FINISHES

- A. Colors and Surface Textures: For exposed sign material that requires selection of materials with integral or applied colors, surface textures or other characteristics related to appearance, provide color matches indicated.
- B. Metal Finishes: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations.
- C. Aluminum Finishes: Finish designations prefixed by AA conform to the system established by the Aluminum Association for designation aluminum finishes
 - 1. Class II Clear Anodized Fine Satin Finish: AA-M31C21 A31 (Mechanical Finish: Fine satin direction textured' Chemical Finish: Fine matte etched finish' Anodic Coating, Class II Architectural, clear film thicker than 0.4 mil.)
- D. Paints: Paint for signs is acrylic polyurethane enamel, eggshell finish. Paint for background of tactile photo-polymer signs is eggshell finish automotive grade lacquer. All surfaces shall be cleaned, primed and pre-treated according to the manufacturer's specifications and noted in Shop Drawings as part of the finished surface work.
- E. Inks:
 - 1. Inks for metal signs, glass and wall surfaces are Alkyd enamel based inks.
 - 2. Inks for plastic signs are lacquer based inks.
 - 3. Inks for tactile graphics on photo-polymer signs are eggshell finish Low Odor Vinyl Ink.
 - 4. All inks and paints are evenly applied without pin-holes, scratches or application marks. Prime coats or other surface pre-treatments, where recommended by the manufacturers are included in the work and noted in the shop drawings as part of the finished surface work.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Locate sign units and accessories where indicated, locations in accordance with the approved shop drawings. Use mounting methods of the type described and in compliance with manufacturer's instructions.
- B. Install signs plumb, level and true to height indicated, with sign surfaces free from distortion or other defects in appearance.

- C. Shop fabricate signs where practical and deliver to site completely assembled. All joints of such fabricated work are completely smooth without apparent marks showing throughout the finish. All work "broken down" is erected so that all parts fit accurately with hairline joints, with all joints flush. Joints in lighted signs shall be light-proof.
- D. Wall and door mounted signs: Attach to surfaces as follows:
 - 1. Vinyl Tape Mounting: Use very high bond, double sided foam tape, of thickness indicated, to mount signs to smooth nonporous surface. Use construction adhesive in conjunction with foam tape.
 - 2. Silicone Adhesive Mounting: Use appropriate liquid silicone adhesive to attach sign units to irregular, porous, or vinyl-covered surfaces. Use double-sided vinyl tape to hold the sign in place until the adhesive has fully cured.

3.2 CLEANING

- A. Clean and polish installed signs.
- B. Upon completion of the work of this Section in any given area, remove tools and all rubbish and debris from the work area; leave area in broom-clean condition.
- C. Remove all names, stamps and decals of sign manufacturers, and installers. No visible advertising of any kind is permitted.

3.3 SCHEDULES

- A. Classroom signage: nominal 8 by 8 inch size sign, having 1-1/2 inch high letters, identifying the faculty member' family name and Braille strip; verify faculty names and mounting locations with Architect.

End of Section 10 14 00

SECTION 12 24 00 SHADES**PART 1 - GENERAL**

1.1 SUMMARY

- A. Furnish and install the following:
 - 1. Chain driven, manually and electrically operated roller-screens for solar shading, privacy shading.
 - a. Room 101: SHADE-1 – manual, 1% shade fabric
 - b. Room 102: SHADE-2 – motorized, blackout fabric
 - 2. Supplementary items required for shade installation including valences where indicated.
 - 3. Include all required control modules for SHADE-2 to tie-in with the AV control system in addition to touch panel operation.
 - 4. Include Side Channels and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 01 60 00 - PRODUCT REQUIREMENTS: Listing of VOC requirements for adhesives, cleaning/maintenance materials, paints, coatings, and sealants.
- B. Section 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: Procedural and administrative requirements for construction and demolition recycling.
- C. Section 06 10 00 - ROUGH CARPENTRY: Blocking for window shades.
- D. Section 09 29 00 - GYPSUM BOARD:
 - 1. Substrate for window shade systems.
- E. Division 26 - ELECTRICAL: Electrical supply wiring and switches.

1.3 REFERENCES

- A. Referenced Standards: Comply with applicable requirements of the following standards and those others referenced in this Section, under the provisions of Division 01 – GENERAL REQUIREMENTS. The standards referenced herein are included to establish recognized minimum quality only. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. Equivalent quality and testing standards will be acceptable, subject to their timely submission, review and acceptance by the Architect.
 - 1. NFPA 701 - Standard Methods of Fire Tests for Flame-resistance Textiles and Films.

2. UL 214 - Standard for Tests for Flame Propagation of Fabrics and Films.

1.4 PERFORMANCE REQUIREMENTS

- A. Fire performance characteristics; shade material tested in accordance with NFPA 70 1- Vertical Burn Test, rated "FR".

1.5 SUBMITTALS

- A. Submit the following under provisions of Section 01330 - SUBMITTAL PROCEDURES:
 1. Product Literature: Manufacturer's product data sheets, specifications, performance data, physical properties and installation instructions for each item furnished hereunder.
 - a. Provide additional information required for fabric, including: Size limitations, fire resistance information. Identify available shade cloth colors and materials.
 - b. Note on submittals any deviations from specified requirements and the reasons thereof.
 2. Maintenance Information: Fabric maintenance data and recommended cleaning materials, and cleaning and stain removal methods.
 3. Warranty: Provide sample copies of manufacturers' actual warranties for all materials to be furnished under this Section, clearly defining all terms, conditions, and time periods for the coverage thereof.
 4. Certifications:
 - a. Certify the shade system is fully compatible with the specified electrical design.
 - b. Manufacturer shall submit notarized certificate indicating compliance with requirements of specifications and that specified warranty will be provided without restriction.
 - c. Certification of compliance with current building code and environmental regulations: Manufacturer shall certify that materials proposed for use comply with applicable building code and environmental regulations.
 - d. Authorization for Deviations From Specifications: If any deviations from specifications have been accepted, include written description and reasons for deviations. Include authorization for change signed by Owner, Architect, Engineer, and person submitting change. Authorization for change shall also clearly indicate party responsible for remedying defects.
 5. Shop drawings:
 - a. Dimensioned 1/4 inch scale drawings, bearing dimensions of actual measurements taken at the project, where practical.
 - b. Include complete fabrication details and erection drawings.

- c. Include details at existing hollow metal door frames for back-out side channels.
6. Wiring Diagrams and Schematics: Submit detailed wiring diagrams and schematics of the entire system, and each component of the system with a detailed list of the components, wiring schematics, and operational characteristics at every level of operation.
7. Selection Samples:
 - a. 3 by 5 inch size shade cloth and liner sample swatches indicating Manufacturer's full range of colors and patterns available for initial selection.
 - b. Provide additional shade cloth and liner samples, of size requested by Architect, to aid in the Architect's selection.
8. Verification Samples:
 - a. 12 by 12 inch samples of blind fabric illustrating material and color.
 - b. 12 inch lengths of roller assembly.

1.6 QUALITY ASSURANCE

- A. Obtain shade operators and fabric products from a single manufacturer, or from manufacturers recommended by the prime manufacturer of operator.
- B. Notify the Architect where conflicts apply between referenced standards and existing materials, and existing methods of construction.

1.7 QUALIFICATIONS

- A. Installer, with a minimum of 3 years documented experience demonstrating previously successful work of the type specified herein.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver items to the site, until all specified submittals have been submitted to, and approved by, the Architect.
- B. Do not deliver shades to the project until all concrete, masonry, plaster and other wet work has been completed and is dry.
- C. Deliver prefabricated shades to site in labeled protective packages, uniquely identified for each intended location. Schedule delivery of panels to prevent delays of the Work, and minimize on-site storage.

- D. Store materials in manner recommended by shade manufacturer, inside, under cover, and in manner to keep them dry, protected from weather, direct sunlight, surface contamination, corrosion and damage from construction traffic and other causes.
- E. Maintain ambient temperature between 60 and 85 degrees Fahrenheit, and a relative humidity between 20 and 50 percent for a period starting 24 hours before installation of window shades, and maintain until Owner's Final Acceptance.

1.9 FIELD MEASUREMENTS

- A. Take field measurements before preparation of shop drawings and fabrication, where possible, to ensure proper fitting of Work.
- B. Allow for adjustments within specified tolerances wherever taking of field measurements before fabrication might delay Work.

1.10 SEQUENCING AND SCHEDULING

- A. Coordinate the work of this Section with the respective trades responsible for installing interfacing work, and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.
- B. Sequence deliveries to avoid delays, but minimize on-site storage.

1.11 WARRANTY

- A. Furnish the following warranties under provisions of Section 01780 - CLOSEOUT SUBMITTALS.
- B. Manual operating components: Manufacturer's 10 year warranty from Date of Substantial Completion of shade installation. Warranty shall include provisions that installation shall remain operational without fault and include all operating parts, except for the bead chain which is not warranted.
- C. Motorized components: Manufacturer's 1 year warranty from Date of Substantial Completion of project. Warranty shall include provisions that installation shall remain operational without fault for the warranty period including coverage of motor, electrical controls and override circuits.
- D. Shade cloth: Manufacturer's 10 year warranty from Date of Substantial Completion of shade installation. Warranty shall include provision that shade cloth will not fade, deteriorate, sag or warp for the warranty period.

1.12 EXTRA MATERIALS

- A. Provide to Owner, 20 percent extra shade fabric for each size, color and type installed.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 - 1. MechoShade, Long Island City, NY.
 - 2. Draper Shade and Screen Co., Spiceland IN.
 - 3. Hunter Douglas Contract, Poway, CA.
 - 4. Levolor Corporation, Sunnyvale CA.

2.2 SHADE COMPONENTS

- A. Clutch operator: Bi-directional clutch and beaded chain mechanism, fabricated from high-strength glass-fiber -reinforced polyester and high-carbon steel springs. Control loop chain shall endless nickel-plated brass bead chain; plastic bead chain is not acceptable.
 - 1. Furnish flexible offset drive, where required, with universal joint permitting up to 12 degree angle between any two shades with a single operator.
 - 2. Provide all shades with chain hold down, spring-tension pulley and shock absorber.
- B. Rollers: Removable, 1-1/2 inch or larger diameter, extruded aluminum alloy 6063- T5 or alloy 6063-T6 tube with a minimum wall thickness of 0.065 inch.
 - 1. Shade mounting spline: Extruded vinyl spline, enabling shade cloth to be removed without having to remove the tube from retainer brackets or without removing brackets from wall
 - 2. Tube Support: Delrin cover plate shall provide protection from tube dislocation. In the event the tube is pushed out of place, the Delrin end of the mounting plates shall contain the tube preventing the tube from falling out of the bracket.
- C. Mounting Brackets: Zinc chromate finished 16 gage steel in manufacturer's standard configuration for head or wall mounting.
- D. Roller idler assembly: Type 6/6 injected molded nylon or high-strength glass-fiber -

reinforced polyester outside sleeve, with zinc plated steel pin.

- E. Solar /Privacy Fabric, PVC-Free: Basis of Design: MechoShade EcoVeil, woven in a 2 by 2 non-directional basketweave, meeting the following minimal requirements:
1. Minimum thickness: 0.030 inch (0.762 mm).
 2. Flame retardant treated certified in conformance with NFPA 701, UL 214.
 3. Maximum open in weave: 1 percent.
 4. Color: As selected by Architect from manufacturer's standard colors. Basis of Design: Silver Birch.
 5. Fading:
 - a. UV test 200 sun-fade hours: no change.
 - b. UV test 500 sun-fade hours: Maximum 5 percent change.
 6. Seamless up to 126 inch width.
 7. Hem pocket: Provide hem pocket, heat sealed or sewn with bottom weight enclosed.
 8. Fabric warranty: Manufacturer's standard 10 year limited warranty.
 9. Location: Room 101
- F. Black out shade Fabric: PVC Free: Basis of Design: MechoShade, Chelsea Blackout
1. Flame retardant treated certified in conformance with NFPA 701, UL 214.
 2. Color: As selected by Architect from manufacturer's standard colors.
 3. Fading:
 - a. UV test 200 sun-fade hours: no change.
 - b. UV test 500 sun-fade hours: Maximum 5 percent change.
 4. Seamless up to 126 inch width.
 5. Hem pocket: Provide hem pocket, heat sealed or sewn with bottom weight enclosed.
 6. Fabric warranty: Manufacturer's standard 10 year limited warranty.
 7. Location: Room 102

2.3 ELECTRICAL OPERATION

- A. System Description:
1. Ultra-quiet, precision-controlled electronic drive unit housed inside rollertube, controlling shade movement.
 2. Audible noise: Maximum 44 dBA measured 3 feet from electronic drive unit. No audible clicks when motor starts or stops.

3. Allow for all windows within designated space to be integrated under single gang controls. Work scope includes roller shades, drive units, pockets and fascias, shade controls, and power supplies.
 4. Control shade speed for tracking within plus or minus 0.0625 inch throughout entire travel.
 5. Include 10 year power failure memory for preset stops, open and close limits, shade grouping and subgrouping, and system configuration.
 6. Systems with multiple electronic drive units electronically synchronized to start, stop, and move in unison.
- B. Grouping:
1. Keypads and contact closure inputs can control any electronic drive unit without separate group controller.
 2. System groups and subgroups configured at point of control without rewiring and without access to electronic drive unit.
 3. System may contain multiple electronic drive units.
 4. Keypads and interfaces able to operate any group or subgroup of electronic drive units.
- C. System Controls:
1. Shades controlled by built-in shade columns on lighting control or by keypad.
 2. Electronic drive units, keypads, and lighting controls contain microprocessors, allowing high level programming from any source, such as AV control systems.
 3. System devices, including shades and lighting controls, connected through common communication link.
- D. System Performance:
1. One-touch control of shades by means of any combination of the following, keypad, lighting control, or infrared remote, as determined by Architect during shop drawing phase.
 2. Capable of stopping within accuracy of 0.125 inch at any point between open and close limits.
 3. Store over 250 programmable stop points, including open, close, and any other position.
 4. Presets set by 5-second button push and hold from keypad, lighting control, or handheld remote control.
 5. Presets recalled by keypad, contact closure input, infrared receiver, or other lighting control system interface.
 6. Open and close limits programmable from electronic drive unit, lighting

control, wall-mounted keypad, or handheld remote control.

7. System components electro static discharge protected.

E. Master Control Systems:

1. Primary control of shades shall be equal to MechoShade "Multi-Zone Controller" for sun activated, temperature or pre-programmed timer activated controls and automatic adjustment of shade positions. System shall be capable of controlling all zones individually or collectively through four low voltage control wires as indicated in electrical drawings.
2. Each zone shall be capable of being operated by a momentary double-pole, double-throw switch located remotely, overriding automatic controls.
3. Master Controller Hardware:
 - a. Standard IBM XT or AT compatible computer equipped with all necessary interfacing hardware to accept the following inputs:
 - 1) Analog inputs for photocells (solar level detection).
 - 2) Digital inputs for building computer priority commands.
 - 3) Inputs for fire alarm and additional non-designated ports.
 - 4) Cable: 4-wire shielded communication cable.
4. Master Controller Software; shall be capable of providing following functions for each individual zone. These functions must be capable of adjustment or definition by the user through menu driven screens and keyboard, without the need of computer programming knowledge.
 - a. Independently addressable zones.
 - b. User defined shade increment; (up to 10 increments) where increment number zero will represent the fully up position.
 - c. User defined tables which shall correspond to a range of dates and times and shade positions.
 - 1) Each table shall have a user definable set of [solar level] [temperature] [wind speed] conditions, which shall define distinct weather and sun conditions and direct the shades to a specified position.
 - d. User defined priority command positions in case of emergency alarm conditions relayed from other interacting computer systems.
 - e. User defined time of day at which Sub-Master and Local controls which have been locally accessed are returned to master control.
 - f. Display of zone status, along with solar intensity levels and indoor and outdoor temperatures.
 - g. The control system shall be capable of staggering the operation of shade

motors to assure balanced loading of the electrical system.

5. Sub-Master:
 - a. Each Sub-Master shall be intelligent and shall decode signals from, and respond interactively with the master.
 - b. Each Sub-Master shall handle up to eight zones as needed.
 - c. Each Sub-Master shall provide local switching by zone and shall be excluded from normal automatic commands by the master. High priority commands shall override this local status.
6. Motor Logic Controller (MLC):
 - a. The Motor Logic Controller shall provide an interface for up to four shade motors in a zone on a floor of the building. Multiple Motor Logic Controllers may be ganged to handle zones with more than four motors.
 - b. In the event of a zone on a floor of the building where more than one Motor Logic Controller are ganged (more than 4 motors), one shall be a master and the rest slave Motor Logic Controllers.
 - c. The Motor Logic Controller shall have the capability of accepting a piggy-back unit to provide local switching of predetermined groups of motors within a zone.

2.4 MOUNTING SYSTEM

- A. Mounting: Wall, jamb, or overhead mounted as indicated, brackets made of 1/8 inch sheet steel to which drive assembly, idle end assembly and center support systems are attached.
 1. Furnish center support brackets to meet span or weight requirements.
 2. Components of brackets shall be interchangeable or replaced without removing bracket from wall or ceiling, inside or outside mount.
 3. Metal support brackets cadmium plated steel. Custom color as selected by the Architect.

2.5 ACCESSORIES

- A. Fascia: One-piece extruded aluminum 6063-T5 alloy with average thickness of 0.062 inches, snap-loc clipped to the brackets without the use of glue, magnetic strip or screws, concealed fastening.
 1. Offset Drive - No Notch Fascia: Chain drive shall fall behind the return edge of the fascia without notching or otherwise defacing the return leg of the fascia.
 2. Fascia filler; readily removable to bridge mullions, transition piece between shades in same material and finish as fascia panel.

- B. Blackout side and sill channels; extruded aluminum with polybond edge seals, and snap-loc mounting brackets;
 - 1. Jamb channels, 1-15/16 inches wide by 1-3/16 inches deep; double jamb channels 2-5/8 inches wide by 1-3/16 inches deep.
 - 2. Coordinate with existing hollow metal door frames for best fit.
- C. Recessed housing, for acoustical plaster ceilings with removable closure plate for access.
- D. Guide cables provide where recommended by manufacturer.

2.6 FABRICATION

- A. Fabrication: Fabricate units to completely fill existing openings, from head-to-sill and jamb-to-jamb. Do not commence fabrication of shade units until field measurements are confirmed.
- B. Fabric shall hang straight and flat without buckling or distortion. Fabric edges shall be straight and without ravel.

2.7 FACTORY FINISHES

- A. Aluminum: PPG Duracron baked enamel in standard colors.
- B. Steel parts, cadmium plated, satin finished, or bonderized prior to painting with baked enamel finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect all surfaces and verify that they are in proper condition to receive the work of this Section. Ensure that supporting substrate is adequate.
- B. Beginning of installation means acceptance of existing project conditions.

3.2 INSTALLATION

- A. Install units to comply with manufacturer's instructions for type of mountings and operations required. Provide units plumb and true, securely anchored in place with recommended hardware and accessories to provide smooth, easy operation.

3.3 TOLERANCES

- A. Maximum variation of gap at window opening perimeter: 1/4 inch.

- B. Maximum offset from level: 1/8 inch.

3.4 ADJUSTING

- A. Adjust units for smooth operation. Replace any units or components which do not operate smoothly and without hindrance.

3.5 CLEANING

- A. Upon completion of the work of this Section in any given area, remove tools, equipment and all rubbish and debris from the work area; leave area in broom-clean condition.

END OF SECTION

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SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION**PART 1 - GENERAL**

1.1 SUMMARY

A. The Work of this Section includes:

1. Sleeves without waterstop.
2. Grout.
3. Silicone sealants.
4. Escutcheons.

1.2 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the fire-suppression equipment Sections.
 - a. Include construction details, material descriptions, and dimensions of components.
 - b. Include operating characteristics and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 COORDINATION

- A. Coordinate features of installed units, and accessory devices to be compatible with the following:

1. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge (0.6 mm) minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.

6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

C. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
 - a. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.2 ESCUTCHEONS

A. Escutcheon Types:

1. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.

B. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

- A. Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.2 INSTALLATION OF SLEEVES, GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, and walls.
- B. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.
- C. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe

penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.3 INSTALLATION OF ESCUTCHEONS

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.4 FIELD QUALITY CONTROL

- A. Sleeves and Sleeve Seals:
 - 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
 - 2. Prepare test and inspection reports.
- B. Escutcheons:
 - 1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.5 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Interior Walls and Partitions:
 - a. Sleeves without waterstops.

3.6 ESCUTCHEONS APPLICATION

- A. Escutcheons for New Piping and Relocated Existing Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - 4. Bare Piping in Unfinished Service Spaces:
 - a. One piece, steel with polished, chrome-plated finish.

5. Bare Piping in Equipment Rooms:
 - a. One piece, steel with polished, chrome-plated finish.
- B. Escutcheons for Existing Piping to Remain:
 1. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 2. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and with OD that completely covers opening.
 1. New Piping and Relocated Existing Piping: One piece, floor plate.
 2. Existing Piping: Split floor plate.

END OF SECTION 21 05 00

SECTION 21 05 29 - HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Fastener systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for pipes capable of supporting combined weight of supported systems.

- B. NFPA Compliance: Comply with NFPA 13.

- C. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.3 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated steel.

2.4 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Stainless Steel: ASTM A240/A240M.
- D. Grout: ASTM C1107/C1107M, 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

3.1 APPLICATION

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. 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. Install in accordance with approvals and listings.
- C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- D. 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.
- E. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 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.

3.4 HANGER AND SUPPORT SCHEDULE

- A. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
- B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- C. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- D. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
 - 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
- E. Hanger-Rod Attachments: Comply with NFPA requirements.
- F. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. C-Clamps (MSS Type 23): For structural shapes.
 - 3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- G. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 21 05 29

SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel pipe and fittings.
 - 2. Sprinkler piping specialties.
 - 3. Sprinklers.

1.2 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, or BIM model, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.
- B. Qualification Data: For qualified Installer.
- C. Design Data:
 - 1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Field Test Reports:
 - 1. 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."
 - 2. Fire-hydrant flow test report.
- E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:

- 1. Installer's responsibilities include designing, fabricating, and installing sprinkler 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.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

- 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of sprinkler service.
- 2. Do not proceed with interruption of sprinkler service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

2.2 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Black Steel Pipe: ASTM A53/A53M, Type E. Pipe ends may be factory or field formed to match joining method.

2.3 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:

- 1. Standard: UL 213.
- 2. Pressure Rating: 175-psig minimum.
- 3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.

4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Adjustable Drop Nipples:

1. Standard: UL 1474.
2. Pressure Rating: 300 psig.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

C. Flexible Sprinkler Hose Fittings:

1. Standard: UL 1474.
2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
3. Pressure Rating: 175-psig minimum.
4. Size: Same as connected piping, for sprinkler.

2.4 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
1. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Sprinkler Finishes: Chrome plated or White.
- E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat or white finish, one piece, flat.
- F. Sprinkler Guards:
1. Standard: UL 199.
 2. Type: Wire cage with fastening device for attaching to sprinkler.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

- B. Report test results promptly and in writing.

3.2 INSTALLATION OF PIPING

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- E. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- F. Fill sprinkler system piping with water.
- G. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- H. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- G. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
 - H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
 - I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- 3.4 INSTALLATION OF SPRINKLERS
- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
 - B. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.
- 3.5 FIELD QUALITY CONTROL
- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative]:
 1. Leak Test: After installation, charge systems 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. Energize circuits to electrical equipment and devices.
 5. Coordinate with fire-alarm tests. Operate as required.
 - B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
 - C. Prepare test and inspection reports.
- 3.6 CLEANING
- A. Clean dirt and debris from sprinklers.
 - B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.
- 3.7 PIPING SCHEDULE
- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
 - B. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 1. Standard-weight black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Standard-weight, black-steel pipe with roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.8 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Concealed pendent sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 21 13 13

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Sleeves without waterstop.
3. Sleeves with waterstop.
4. Stack-sleeve fittings.
5. Sleeve-seal systems.
6. Grout.
7. Silicone sealants.
8. Escutcheons.
9. Thermometers, liquid in glass.
10. Duct-thermometer mounting brackets.
11. Thermowells.

1.2 DEFINITIONS

- A. Existing Piping To Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.
 - a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
 - b. Include operating characteristics and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of meter and gauge to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.7 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Motor Requirements, General:
 - 1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
 - 2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
 - 3. Comply with NEMA MG 1 unless otherwise indicated.
 - 4. Comply with IEEE 841 for severe-duty motors.
- B. Motor Characteristics:
 - 1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
 - 2. 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.
- C. Polyphase Motors:
 - 1. Description: NEMA MG 1, Design B, medium induction motor.
 - 2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
 - 3. Service Factor: 1.15.
 - 4. Multispeed Motors: Variable torque.
 - a. For motors with 2:1 speed ratio, consequent pole, single winding.
 - b. For motors with other than 2:1 speed ratio, separate winding for each speed.
 - 5. Multispeed Motors, Two Winding: Separate winding for each speed.
 - 6. Rotor: Random-wound, squirrel cage.

7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Code Letter Designation:
 - a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
 - b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.
11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - a. 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.
 - b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor.
 - b. Split phase.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. 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 will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts 120 V or 240 V single-phase AC power to three-phase DC power to operate the brushless DC motor.

2. Three-phase power motor module with permanent magnet rotor.
3. Circuit board or digital speed controller/LED display.
4. Building Automation System Interface: Via AC voltage signal, DC voltage signal, or Digital Serial Interface (DSI).

2.2 HYDRONIC AND STEAM SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop – Penetrating interior walls and partitions

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 0.0239-inch minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

B. Sleeves with Waterstop – Penetrating exterior walls, slabs on grade, and elevated slabs

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Advance Products & Systems, LLC.](#)
 - b. [CALPICO, Inc.](#)
 - c. [GPT; an EnPro Industries company.](#)
 - d. [Metraflex Company \(The\).](#)
2. Description: Manufactured PVC/HDPE or galvanized steel, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

C. Stack Sleeve Fittings

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Jay R. Smith Mfg Co; a division of Morris Group International.](#)
 - b. [Wade; a subsidiary of McWane Inc.](#)
 - c. [Zurn Industries, LLC.](#)
2. Description: Manufactured, Dura-coated, Duco-coated, or galvanized cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with setscrews.

D. Sleeve Seal Systems

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Advance Products & Systems, LLC.](#)
 - b. [CALPICO, Inc.](#)
 - c. Garlock
 - d. [GPT; an EnPro Industries company.](#)

- e. [Metraflex Company \(The\)](#).
 - f. [Proco Products, Inc.](#)
2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
- a. Designed to form a hydrostatic seal of 20 psig.
 - b. Sealing Elements: interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - 1) EPDM-rubber for chilled water
 - 2) High-temperature-silicone for hot water and steam applications
 - c. Pressure Plates: Carbon steel or Composite plastic.
 - d. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.
- E. Grout
- 1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
 - 2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 - 3. Design Mix: 5000 psi, 28-day compressive strength.
 - 4. Packaging: Premixed and factory packaged.
- F. Silicone Sealants – Non-concrete wall penetrations only
- 1. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
 - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1) [GE Construction Sealants; Momentive Performance Materials Inc.](#)
 - 2) [Permathane; ITW Polymer Sealants North America.](#)
 - 3) [Polymeric Systems, Inc.](#)
 - 4) [Sherwin-Williams Company \(The\)](#).
 - 5) [Sika Corporation.](#)
 - 6) [The Dow Chemical Company.](#)
 - 7) [Tremco Incorporated.](#)
 - b. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - c. [Verify sealant complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 ESCUTCHEONS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.
3. Jones Stephens Corp.
4. Keeney Manufacturing Company (The).
5. Mid-America Fittings, LLC; A Midland Industries Company.
6. ProFlo; a Ferguson Enterprises, Inc. brand.

B. Escutcheon Types:

1. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

2.4 METERS AND GAUGES FOR HVAC PIPING

A. Thermometers, Liquid in Glass - Metal Case, Industrial Style:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Trerice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. Winters Instruments - U.S.
2. Source Limitations: Provide liquid-in-glass, metal-case, industrial-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
5. Case Form: Adjustable angle unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue organic liquid.
7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
8. Window: Glass or plastic.
9. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
10. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Duct-Thermometer Mounting Brackets:

1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

C. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR (90-10 copper nickel).
4. Material for Use with Steel Piping: CRES (stainless steel).
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

D. Test Plugs:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. IMI Flow Design, Inc.
 - b. Nexus Valve, Inc.; Aalberts Hydronic Flow Control.
 - c. Trerice, H. O. Co.
 - d. WATTS; A Watts Water Technologies Company.
 - e. Weiss Instruments, Inc.
2. Source Limitations: Provide test plugs from single manufacturer.
3. Description: Test-station fitting made for insertion in piping tee fitting.
4. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
5. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.
6. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
7. Core Inserts: EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 2. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.
- D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Division 07.
- 3.2 INSTALLATION OF SLEEVES WITH WATERSTOP
- A. Install sleeve with waterstop as new walls and slabs are constructed.
 - B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.
 - C. Secure nailing flanges to wooden concrete forms.
 - D. Using grout or silicone sealant, seal space around outside of sleeves.
- 3.3 INSTALLATION OF STACK-SLEEVE FITTINGS
- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07.
 3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.
 - B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Division 07.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 INSTALLATION OF ESCUTCHEONS

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping and Relocated Existing Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
- b. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
- e. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- f. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:

- a. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

- 1. New Piping and Relocated Existing Piping: Split floor plate.
- 2. Existing Piping to Remain: Split floor plate.

3.6 INSTALLATION OF METERS AND GAUGES

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- I. Install flow indicators in piping systems in accessible positions for easy viewing.
- J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- K. Install flowmeter elements in accessible positions in piping systems.
- L. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- M. Install permanent indicators on walls or brackets in accessible and readable positions.
- N. Install connection fittings in accessible locations for attachment to portable indicators.
- O. Thermometer stems are to be of length to match thermowell insertion length.
- P. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- Q. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Two inlets and two outlets of each chiller.
 - 4. Inlet and outlet of each hydronic coil in air-handling units.
 - 5. Two inlets and two outlets of each hydronic heat exchanger.
 - 6. Inlet and outlet of each thermal-storage tank.
 - 7. Outside-, return-, supply-, and mixed-air ducts for each air handler or energy recovery ventilator over 2,000cfm airflow capacity.
- R. Install pressure gauges in the following locations:
 - 1. Inlet and Discharge of each pressure-reducing valve.

2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.
4. All each floor takeoff of steam system.
5. At inlet of each steam coil or heat exchanger connection.

3.7 CONNECTIONS

- A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.8 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

3.9 FIELD QUALITY CONTROL

- A. Sleeves and Sleeve Seals:
 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

- B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.10 SLEEVE SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls above and below Grade: Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 2. Concrete Slabs-on-Grade: Sleeves with waterstops.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs above Grade: Sleeves with waterstops or stack-sleeve fittings.
 4. Interior Walls and Partitions: Sleeves without waterstops.

3.11 THERMOMETER SCHEDULE

- A. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F and 0 to plus 115 deg C.
- B. Scale Range for Air Ducts: Minus 40 to plus 110 deg F

END OF SECTION 23 05 00

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Thermal-hanger shield inserts.
6. Fastener systems.
7. Pipe stands.
8. Equipment stands.
9. Equipment supports.

B. Related Requirements:

1. Section 23 21 13 "Hydronic Piping Distribution Systems" for pipe guides and anchors.
2. Section 23 05 48.13 "Vibration Controls for HVAC" for vibration isolation devices.
3. Section 23 31 13 "Air Distribution System – Metal Ducts" for duct hangers and supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
 - 3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe and Tube Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - c. [Flex-Strut Inc.](#)
 - d. [G-Strut.](#)
 - e. [Haydon Corporation.](#)
 - f. [MIRO Industries.](#)
 - g. [Rooftop Support Systems; Eberl Iron Works, Inc.](#)
 - h. [Unistrut; Atkore International.](#)
 - i. [Wesanco, Inc.](#)
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channels: Continuous slotted of the following material
 - a. Carbon-steel – For dry locations indoors
 - b. Galvanized steel – For outdoor locations
 - c. Type 304 stainless steel – For wet or corrosive locations.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel or stainless steel – matching channel material.
8. Metallic Coating – Carbon steel:
 - a. Plain – Indoor dry location
 - b. Pregalvanized G90 – Outdoor installation
9. Plastic Coating: PVC.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [Buckaroos, Inc.](#)
 2. [CADDY; brand of nVent Electrical plc.](#)
 3. [Carpenter & Paterson, Inc.](#)
 4. [KB Enterprise.](#)
 5. [National Pipe Hanger Corporation.](#)
 6. [Pipe Shields Inc.](#)

7. [Piping Technology & Products, Inc.](#)
8. [Rilco Manufacturing Co., Inc.](#)
9. [Value Engineered Products, Inc.](#)

- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi; ASTM C552, Type II cellular glass with 100-psi; or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Powder actuated fasteners are not acceptable.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - b. [Empire Industries, Inc.](#)
 - c. [Hilti, Inc.](#)
 - d. [ITW Ramset/Red Head; Illinois Tool Works, Inc.](#)
 - e. [MKT Fastening, LLC.](#)
 2. Indoor Applications: Zinc-coated or stainless steel.
 3. Outdoor Applications: Stainless steel.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [MIRO Industries.](#)
 - b. [PHP Systems/Design.](#)
 - c. [RectorSeal HVAC; a CSW Industrials Company.](#)
 2. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
4. Hardware: Galvanized steel or polycarbonate.
5. Accessories: Protection pads.

- C. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb. All steel components shall be galvanized.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 OUTDOOR EQUIPMENT STANDS

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

1. MIRO Industries.
2. RectorSeal HVAC; a CSW Industrials Company.

- B. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof supported outdoor equipment components, without roof membrane penetration, in a pre-fabricated system that can be modularly-assembled on site.

- C. Foot Material: Rubber or polypropylene.

- D. Rails Material: Hot dip galvanized carbon steel.

- E. Wind/Sliding Load Resistance: Up to 125 mph minimum.

2.10 MATERIALS

- A. Aluminum: ASTM B221.

- B. Carbon Steel: ASTM A1011/A1011M.

- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

- D. Stainless Steel: ASTM A240/A240M.

- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

- F. Grout: ASTM C1107/C1107M, 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

3.1 APPLICATION

- A. Comply with requirements in Division 07 for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-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 for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. 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.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 for curbs.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.

- K. 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.
- L. Do not attach any HVAC piping or equipment supports from metal roof deck.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Refer to Hanger and Support schedule for shield dimensions.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless steel pipe hangers and stainless steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.

- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Nominal Pipe Size (inch)	Max Span (feet)	Minimum Threaded Rod Size (inch)	Hanger Type	Shield Dimensions for Insulated Piping (Length x Thickness, inch)
3/4	5	0.375	Clevis	12 x 0.048
1	5	0.375	Clevis	
1-1/4	6	0.375	Clevis	
1-1/2	8	0.375	Clevis	
2	8	0.375	Clevis	
2-1/2	9	0.5	Clevis	
3	10	0.5	Clevis	18 x 0.06
4	12	0.625	One rod roller	
5	12	0.625	One rod roller	
6	12	0.625	One rod roller	24 x 0.105
8 – 12	12	0.75 (two)	Two rod roller	
14 – 18	12	0.875 (two)	Two rod roller	
20 – 24	12	1.25 (two)	Two rod roller	

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 3. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 4. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 5. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 6. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
 7. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
 8. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Vertical piping supports maximum spacing shall be 10 feet for copper pipe and 15 feet for steel pipe.
 2. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 3. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. 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.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- 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-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 23 05 48.13 - VIBRATION AND WIND CONTROLS FOR HVAC**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01, and Division 20 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Restrained-spring isolators.
6. Pipe-riser resilient support.
7. Resilient pipe guides.
8. Elastomeric hangers.
9. Spring hangers.
10. Snubbers.
11. Restraints - rigid type.
12. Restraints - cable type.
13. Restraint accessories.
14. Post-installed concrete anchors.
15. Concrete inserts.
16. Vibration isolation equipment bases.
17. Restrained isolation roof-curb rails.

B. Related Requirements:

1. Division 21 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Division 22 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.

3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and wind-force-restraint component.
 4. Annotate to indicate application of each product submitted and compliance with requirements.
 5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases.
 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal:
1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:
 - a. Vibration Isolator and Wind-Load-Restraint Selection: Select vibration isolators, wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
 - b. 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 by professional engineer that riser system was examined for excessive stress and that none exists.
 - c. Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.
 - d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
 - e. Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
 2. Wind-Restraint Detail Drawing:
 - a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.
 - c. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
 3. All delegated-design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
 4. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).

5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. 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 was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.
 1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
 2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
 3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing, an evaluation service member of ICC-ES, or an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design system.
 - 1. Wind-Load Performance: Equipment shall withstand the effects of high wind events determined in accordance with ASCE/SEI 7-05.
- B. Wind-Load Design Calculations:
 - 1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
 - a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate design wind-load calculations with vibration isolation requirements. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
 - 2. Design wind pressure "p" for external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
 - a. PART 1: Low-Rise Buildings.
 - b. PART 2: Low-Rise Buildings (Simplified).
 - c. PART 3: Buildings with "h" less than 60 feet.
 - d. PART 4: Buildings with "h" greater than 60 feet and less than 160 feet.
 - e. PART 5: Open Buildings.
 - 3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
 - a. Risk Category: III.
 - b. h = Mean Roof Height: 40 feet.
 - c. V = Basic Wind Speed: 125mph.
- C. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.
- D. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- E. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Ace Mountings Co., Inc.](#)
 - b. [CADDY; brand of nVent Electrical plc.](#)
 - c. [California Dynamics Corporation.](#)
 - d. [Kinetics Noise Control, Inc.](#)
 - e. [Mason Industries, Inc.](#)
 - f. [NOVIA; a division of Carpenter & Paterson.](#)
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Minimum deflection as indicated on Drawings.
5. Pad Material: Oil- and water-resistant rubber.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.
 - a. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Ace Mountings Co., Inc.](#)
 - b. [CADDY; brand of nVent Electrical plc.](#)
 - c. [California Dynamics Corporation.](#)
 - d. [Kinetics Noise Control, Inc.](#)
 - e. [Mason Industries, Inc.](#)
 - f. [NOVIA; a division of Carpenter & Paterson.](#)
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Ace Mountings Co., Inc.](#)
 - b. [CADDY; brand of nVent Electrical plc.](#)
 - c. [Kinetics Noise Control, Inc.](#)
 - d. [Mason Industries, Inc.](#)
 - e. [NOVIA; a division of Carpenter & Paterson.](#)
 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
 - b. Top plate with threaded mounting holes and elastomeric pad.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.5 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Ace Mountings Co., Inc.](#)
 - b. [CADDY; brand of nVent Electrical plc.](#)
 - c. [California Dynamics Corporation.](#)
 - d. [Kinetics Noise Control, Inc.](#)
 - e. [Mason Industries, Inc.](#)
 - f. [NOVIA; a division of Carpenter & Paterson.](#)
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.6 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Ace Mountings Co., Inc.](#)
 - b. [CADDY; brand of nVent Electrical plc.](#)
 - c. [California Dynamics Corporation.](#)
 - d. [Kinetics Noise Control, Inc.](#)
 - e. [Mason Industries, Inc.](#)
 - f. [NOVIA; a division of Carpenter & Paterson.](#)
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 rated vertical stiffness.
6. Minimum deflection as indicated on Drawings.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
10. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.7 SNUBBERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [CADDY; brand of nVent Electrical plc.](#)
 2. [Kinetics Noise Control, Inc.](#)
 3. [Mason Industries, Inc.](#)
 4. [VMC GROUP.](#)
 5. [Vibration Management Corp.](#)
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
 2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
 3. Anchors in Masonry: Design in accordance with TMS 402.
 4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.8 VIBRATION ISOLATION EQUIPMENT BASES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [CADDY; brand of nVent Electrical plc.](#)
2. [California Dynamics Corporation.](#)
3. [Kinetics Noise Control, Inc.](#)
4. [Mason Industries, Inc.](#)
5. [NOVIA; a division of Carpenter & Paterson.](#)

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. 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.
 - a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. 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.
 - a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. 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.

2.9 RESTRAINTS - RIGID TYPE

A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [CADDY; brand of nVent Electrical plc.](#)
2. [California Dynamics Corporation.](#)

3. [Hilti, Inc.](#)
4. [Unistrut; Atkore International.](#)

- B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.10 RESTRAINTS - CABLE TYPE

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [CADDY; brand of nVent Electrical plc.](#)
 2. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 3. [Gripple Inc.](#)
 4. [Loos & Co. Inc.](#)
 5. [VMC GROUP.](#)
- B. Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
- C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19-10. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.11 RESTRAINT ACCESSORIES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [CADDY; brand of nVent Electrical plc.](#)
 2. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 3. [Hilti, Inc.](#)
 4. [Mason Industries, Inc.](#)
 5. [Unistrut; Atkore International.](#)
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.12 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

- 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - b. [Hilti, Inc.](#)
 - c. [Mason Industries, Inc.](#)
 - d. [Powers Fasteners.](#)
 - e. [Unistrut; Atkore International.](#)
- 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

- 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - b. [Hilti, Inc.](#)
 - c. [Mason Industries, Inc.](#)
 - d. [Powers Fasteners.](#)
 - e. [Unistrut; Atkore International.](#)
- 2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13.

- 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
- 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

- 1. Undercut expansion anchors are permitted.

2.13 CONCRETE INSERTS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - 2. [Hilti, Inc.](#)
 - 3. [Mason Industries, Inc.](#)
 - 4. [Powers Fasteners.](#)
 - 5. [Unistrut; Atkore International.](#)
- B. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- 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.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind-load forces.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

3.3 SCHEDULE FOR EQUIPMENT VIBRATION ISOLATION DEVICE APPLICATIONS

- A. Provide vibration isolators of the type and minimum deflection distance indicated in the tables below. Isolators shall be provided for all motorized, rotating, piston driven, and vibrating equipment per the schedule tables. Isolator selections shall be based upon approved equipment submittals.

Base Types		Isolator Types	
A	No base, isolators attached directly to equipment	1	Pad, rubber
B	Structural steel rails or base	2	Rubber floor isolator or hanger
C	Concrete inertia base	3	Spring floor isolator or hanger
D	Curb-mounted base	4	Restrained spring isolator
		5	Thrust restraint

Heat Pumps, Fan-Coils, VRF Indoor Cassettes, Computer Room Units (CRAC), Unit Heaters, and Cabinet unit heaters – Vibration Isolation Schedule															
Equipment Type	Horsepower and Other	RPM	Floor Span												Notes
			Slab on Grade			Up to 20ft			20 to 30ft			30 to 40ft			
			Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	
All	All	All	A	3	0.75	A	3	0.75	A	3	0.75	A/D	3	1.5	

Condensing Units - Vibration Isolation Schedule															
Equipment Type	Horsepower and Other	RPM	Floor Span												Notes
			Slab on Grade			Up to 20ft			20 to 30ft			30 to 40ft			
			Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	
All	All	All	A	1	0.25	A	4	0.75	A	4	1.5	A/D	4	1.5	

Packaged Air Handler, Air Conditioner, and H&V Units - Vibration Isolation Schedule															
Equipment Type	Horsepower and Static Pressure	RPM	Floor Span												Notes
			Slab on Grade			Up to 20ft			20 to 30ft			30 to 40ft			
			Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	
All	<10HP	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75	
	≤15HP	Up to 300	A	3	0.75	A	3	3.5	A	3	3.5	C	3	3.5	
		301 to 500	A	3	0.75	A	3	2.5	A	3	2.5	A	3	2.5	
	>15HP, ≤4 in. SP	501 and up	A	3	0.75	A	3	1.5	A	3	1.5	A	3	1.5	
	>15HP, >4 in. SP	Up to 300	B	3	0.75	C	3	3.5	C	3	3.5	C	3	3.5	
		301 to 500	B	3	0.75	C	3	1.5	C	3	2.5	C	3	2.5	
		501 and up	B	3	0.75	C	3	1.5	C	3	1.5	C	3	2.5	

Ducted Rotating Equipment - Vibration Isolation Schedule															
Equipment Type	Airflow	RPM	Floor Span												Notes
			Slab on Grade			Up to 20ft			20 to 30ft			30 to 40ft			

			Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	Base Type	Isolator Type	Min Defl, inch	
Small Fans, Fan-Powered Boxes	≤600cfm	All	A	3	0.5	A	3	0.5	A	3	0.5	A	3	0.5	
	>601cfm	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75	

3.4 SCHEDULE FOR PIPING VIBRATION ISOLATION DEVICE APPLICATIONS

A. Suspended piping vibration isolation

1. Isolation hangers shall be used for all piping in equipment rooms and up to 50 feet from vibration-isolated equipment and pressure-regulating valve (PRV) stations. At least the first three hangers from the equipment should provide the same deflection as the equipment isolators, with a maximum limitation of 2-inch deflection; the remaining hangers should be spring or combination spring and rubber with 0.75 inch deflection.
2. The first two hangers adjacent to the equipment should be the positioning or pre-compressed type.
3. Piping over 2 NPS that is suspended below or within 50 feet of conference rooms, classrooms, multipurpose rooms, auditoriums, and concert halls shall be hung with isolation hangers.

B. Floor supported piping vibration isolation

1. Floor supports for piping in equipment rooms and adjacent to isolated equipment shall be supported by vibration isolators. The isolators shall be selected according to guidelines for Suspended Piping hangers. The first two adjacent floor support should be the restrained spring type, with a blocking feature that prevents load transfer to equipment flanges as the piping is filled or drained.
2. Where pipe is subjected to large thermal movement, a slide plate (PTFE, graphite, or steel) shall be installed on top of the isolator, and a thermal barrier shall be used when rubber products are installed directly beneath steam or hot water lines.

C. Pipe riser supports vibration isolation

1. Provide resilient pipe riser anchor support at midpoint of riser. The remaining pipe supports at each floor or structural level shall be spring isolated to support riser and allow thermal expansion.
2. Provide spring hangers for first three hangers connected to branch piping at each floor level takeoff.

3.5 INSTALLATION OF VIBRATION AND WIND-LOAD CONTROL DEVICES

- A. Provide vibration and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 "Cast-in-Place Concrete."
- C. Installation of vibration isolators and wind-load restraints must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- D. Comply with requirements in Division 07 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- E. Equipment Restraints:
 1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 3. Install wind-load-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- F. Piping Restraints:
1. Comply with requirements in MSS SP-127.
 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 2. Brace a change of direction longer than 12 feet.
- G. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.
- H. Install wind-load-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- L. Post-Installed Concrete Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.
- 3.6 ACCOMMODATION OF DIFFERENTIAL MOTION
- A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Division 23 "Hydronic Piping Distribution Systems" for piping flexible connections.
- 3.7 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES
- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 "Cast-in-Place Concrete."
- B. Coordinate dimensions of equipment bases with requirements of isolated equipment specified in this and other Sections. Where dimensions of base are indicated on Drawings, they may require adjustment to accommodate isolated equipment.

3.8 ADJUSTING

- A. Adjust isolators after system 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.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. Test and adjust restrained-air-spring isolator controls and safeties.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

END OF SECTION 23 05 48.13

SECTION 23 05 53 - IDENTIFICATION FOR HVAC**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
1. Equipment labels.
 2. Warning signs and labels.
 3. Warning tape.
 4. Pipe labels.
 5. Duct labels.
 6. Valve tags.
 7. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve-numbering scheme.
- E. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Brady Corporation.](#)
 - b. [Carlton Industries, LP.](#)
 - c. [Champion America.](#)
 - d. [Craftmark Pipe Markers.](#)
 - e. [Kolbi Pipe Marker Co.](#)
 - f. [LEM Products Inc.](#)
 - g. [Marking Services Inc.](#)
 - h. [Pipemarket.com; Brimar Industries, Inc.](#)
 - i. [Seton Identification Products; a Brady Corporation company.](#)
 - j. [emedco.](#)
 2. Material and Thickness:

- a. Indoors – Brass 0.032-inch minimum thickness.
 - b. Outdoors – stainless steel, 0.025-inch minimum thickness.
 - c. Provide with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Fasteners: Stainless steel rivets or self-tapping screws.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Brady Corporation.](#)
 - b. [Carlton Industries, LP.](#)
 - c. [Champion America.](#)
 - d. [Craftmark Pipe Markers.](#)
 - e. [Kolbi Pipe Marker Co.](#)
 - f. [LEM Products Inc.](#)
 - g. [Marking Services Inc.](#)
 - h. [Pipemarker.com; Brimar Industries, Inc.](#)
 - i. [Seton Identification Products; a Brady Corporation company.](#)
 - j. [emedco.](#)
 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
 3. Letter and Background Color: As indicated for specific application under Part 3.
 4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of 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.
 7. Fasteners: Stainless steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Brady Corporation.](#)
 2. [Carlton Industries, LP.](#)
 3. [Champion America.](#)
 4. [Craftmark Pipe Markers.](#)
 5. [LEM Products Inc.](#)
 6. [Marking Services Inc.](#)
 7. [National Marker Company.](#)
 8. [Pipemarker.com; Brimar Industries, Inc.](#)
 9. [Seton Identification Products; a Brady Corporation company.](#)
 10. [Stranco, Inc.](#)
 11. [emedco.](#)
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of 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.
- G. Fasteners: Stainless steel rivets or self-taping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E and other applicable codes and standards.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

- A. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Brady Corporation.](#)
 2. [Craftmark Pipe Markers.](#)
 3. [National Marker Company.](#)
 4. [Pipemarker.com; Brimar Industries, Inc.](#)
 5. [Seton Identification Products; a Brady Corporation company.](#)
- B. Material: Vinyl.
- C. Minimum Thickness: 0.005 inch.
- D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

- F. Maximum Temperature: 160 deg F.
- G. Minimum Width: 4 inches.

2.4 PIPE LABELS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.](#)
 - 2. [Brady Corporation.](#)
 - 3. [Carlton Industries, LP.](#)
 - 4. [Champion America.](#)
 - 5. [Craftmark Pipe Markers.](#)
 - 6. [Kolbi Pipe Marker Co.](#)
 - 7. [LEM Products Inc.](#)
 - 8. [Marking Services Inc.](#)
 - 9. [Pipemarket.com; Brimar Industries, Inc.](#)
 - 10. [Seton Identification Products; a Brady Corporation company.](#)
 - 11. [emedco.](#)
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
 - 1. Pipe size.
 - 2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
 - 3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.5 DUCT LABELS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Brady Corporation.](#)
 - 2. [Carlton Industries, LP.](#)
 - 3. [Champion America.](#)
 - 4. [Craftmark Pipe Markers.](#)
 - 5. [Kolbi Pipe Marker Co.](#)
 - 6. [LEM Products Inc.](#)
 - 7. [Marking Services Inc.](#)
 - 8. [Pipemarket.com; Brimar Industries, Inc.](#)
 - 9. [Seton Identification Products; a Brady Corporation company.](#)

10. [emedco](#).

- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of 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.
- G. Fasteners: Stainless steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:
 - 1. Duct size.
 - 2. Flow-Direction Arrows: Include flow-direction arrows on main distribution ducts. Arrows may be either integral with label or may be applied separately.

2.6 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.04-inch or anodized aluminum, 0.031-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire or S-hook.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Reinforced grommet and wire or string.

3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of mechanical equipment.
- B. Sign and Label Colors:
 1. White letters on an ANSI Z535.1 safety-blue background.
- C. Locate equipment labels where accessible and visible.
- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

- A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.
- B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.
- C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in Division 09.
- B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

- C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Within 3 ft. of each valve and control device.
 - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 3. Within 3 ft. of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.
- D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- E. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- F. Pipe-Label Color Schedule:
 - 1. Chilled-Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 2. Condenser-Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 3. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 4. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.
 - 5. Low-Pressure Steam Piping: Black letters on an ANSI Z535.1 safety-yellow background.
 - 6. High-Pressure Steam Piping: Black letters on an ANSI Z535.1 safety-yellow background.
 - 7. Steam Condensate Piping: Black letters on an ANSI Z535.1 safety-yellow background.
 - 8. Toxic and Corrosive Fluids: Black letters on an ANSI Z535.1 safety-orange background.
 - 9. Flammable Fluids: Black letters on an ANSI Z535.1 safety-yellow background.
 - 10. Combustible Fluids: White letters on an ANSI Z535.1 safety-brown background.
 - 11. Potable and Other Water: White letters on an ANSI Z535.1 safety-green background.
 - 12. Compressed Air: White letters on an ANSI Z535.1 safety-blue background.

3.6 INSTALLATION OF DUCT LABELS

- A. Install self-adhesive duct labels showing service and flow direction with permanent adhesive on air ducts.
 - 1. Provide labels in the following color codes:
 - a. For air supply ducts: White letters on blue background.
 - b. For air return ducts: White letters on blue background.
 - c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.
 - d. ASME A13.1 Colors and Designs: For hazardous material exhaust (including fumehood, biosafety cabinet, and other equipment exhaust).
- B. Stenciled Duct-Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.
 - 1. For all air ducts: Black letters on white background.
- C. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 ft. where exposed or are concealed by removable ceiling system.

D. Stenciled Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Black letters on White background.

3.7 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

- a. Chilled Water: 1-1/2 inches, round.
- b. Condenser Water: 1-1/2 inches, round.
- c. Refrigerant: 1-1/2 inches, round.
- d. Hot Water: 1-1/2 inches, round.
- e. Gas: 1-1/2 inches, round.
- f. Low-Pressure Steam: 1-1/2 inches, round.
- g. High-Pressure Steam: 1-1/2 inches, round.
- h. Steam Condensate: 1-1/2 inches, round.

2. Valve-Tag Colors:

- a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

3.8 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where indicated on Drawings, scheduled, and where required by Authority Having Jurisdiction (AHJ).

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Testing, Adjusting, and Balancing of Air Systems
 - 2. Testing, adjusting, and balancing of equipment.
 - 3. Testing, adjusting, and balancing of existing HVAC systems and equipment.
 - 4. Duct leakage tests verification.
 - 5. Pipe leakage tests verification.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 60 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 90 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.

- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB or TABB:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
 - 1. [ASHRAE 62.1 Compliance](#): Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums **[and underfloor air plenums]** used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data, including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.
- L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
 2. Strategies and step-by-step procedures for balancing the systems.
 3. Instrumentation to be used.
 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.
 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled and cleaned.
 - f. Control valves are functioning in accordance with the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in ASHRAE 111 and in this Section. Where conflicting procedures are found, comply with ASHRAE 111 per ASHRAE 62.1, Section 7.2.2 - "Air Balancing." When this section and ASHRAE 111 does not contain sufficient procedures, select from one of the following standards:
- a. AABC's "National Standards for Total System Balance"
 - b. NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"
 - c. SMACNA – "HVAC Systems – Testing, Adjusting and Balancing"

- B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

- A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
 - 1. Motors.
 - 2. Fans and ventilators.
 - 3. Heat exchangers.
 - 4. Cooling equipment
 - a. Condensing units.
 - b. Condensers.
 - 5. Air-handling equipment
 - a. Air handling units
 - b. Energy-recovery units.
 - 6. Split-system air conditioners.
 - 7. Coils.
 - 8. Variable-refrigerant-flow systems.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' Record drawings duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from Architect, Owner, Construction Manager, and Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.

- C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.

- D. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 - 6. Measure and record all operating data.
 - 7. Record final fan-performance data.

3.7 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.

- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.8 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

- A. Verify proper rotation of fan(s).
- B. Measure and record entering- and leaving-air temperatures.
- C. Measure and record entering and leaving refrigerant pressures.
- D. Measure and record operating data of compressor(s), fan(s), and motors.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Air pressure drop.
 - 5. Voltage and amperage input of each phase at full load.

6. Calculated kilowatt at full load.
7. Fuse or circuit-breaker rating for overload protection.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.10 DUCT LEAKAGE TESTS

- A. Witness the duct leakage testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.11 PIPE LEAKAGE TESTS

- A. Witness the pipe pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified limits.
- C. Report deficiencies observed.

3.12 HVAC CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 1. Verify HVAC control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.
 4. Verify that controller set points are as indicated.
 5. Verify the operation of lockout or interlock systems.
 6. Verify the operation of valve and damper actuators.
 7. Verify that controlled devices are properly installed and connected to correct controller.
 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.13 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.

2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
3. Heating-Water, Chilled-Water, and Condenser Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.

- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.14 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.15 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans performance forms, including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Heating coil, dry-bulb conditions.
 - e. Face and bypass damper settings at coils.
 - f. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - g. Variable-frequency controller settings for variable-air-volume systems.
 - h. Settings for pressure controller(s).
 - i. Other system operating conditions that affect performance.
 16. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.

2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and speed.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan speed.
 - d. Inlet and discharge static pressure in inches wg.
 - e. For each filter bank, filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
 - j. Outdoor airflow in cfm.
 - k. Return airflow in cfm.
 - l. Outdoor-air damper position.
 - m. Return-air damper position.

- F. Apparatus-Coil Test Reports:
 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.

 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.

- j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- 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. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and speed.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.

- f. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan speed.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- 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 fan and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.

L. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.16 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION**PART 1 - GENERAL**

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Interior supply, return, relief, and exhaust air.

B. Related Requirements:

1. Division 23 "HVAC Equipment Insulation."
2. Division 23 "HVAC Piping Insulation."
3. Division 23 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
 - 1. All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
- F. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290; Type II with factory-applied vinyl jacket; Type III with factory-applied FSK jacket or Type III with factory-applied FSP jacket. Minimum density 1lb/cu.ft. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [CertainTeed; SAINT-GOBAIN.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)
 - c. [Knauf Insulation.](#)
 - d. [Manson Insulation Inc.](#)
 - e. [Owens Corning.](#)
- G. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. Rigid board shall have minimum density 6lb/cu.ft. Semi-rigid board shall have minimum density 2.5lb/cu.ft.
1. For duct and plenum applications in concealed locations and mechanical rooms, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 2. For duct and plenum applications in exposed occupied space, provide insulation with factory-applied ASJ jacket for field painting. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 3. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [CertainTeed; SAINT-GOBAIN.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)
 - c. [Knauf Insulation.](#)
 - d. [Manson Insulation Inc.](#)
 - e. [Owens Corning.](#)
- H. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.
1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [CertainTeed; SAINT-GOBAIN.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)
 - c. [Knauf Insulation.](#)
 - d. [Manson Insulation Inc.](#)
 - e. [Owens Corning.](#)
 2. Semirigid board material with factory-applied FSK jacket.
 3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 2.3 ADHESIVES
- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
 - B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. Childers Brand; H. B. Fuller Construction Products.
 - d. Foster Brand; H. B. Fuller.
 - e. K-Flex USA.
 2. Verify adhesives have a VOC content of 50 g/L or less.
 3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller.
 - d. Mon-Eco Industries, Inc.
 2. Verify fiberglass adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
 3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller.
 - d. Mon-Eco Industries, Inc.
 2. Verify adhesive has a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
 3. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Dow Consumer Solutions.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)
 - c. [P.I.C. Plastics, Inc.](#)
 - d. [Proto Corporation.](#)
 - e. [Sekisui Voltek, LLC.](#)
 - f. [Speedline Corporation.](#)
2. **Verify adhesive has a VOC** content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).
3. **Verify adhesive complies with the** testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 MASTICS AND COATINGS

- A. Materials are compatible with insulation materials, jackets, and substrates.
 1. **VOC Content:** 300 g/L or less.
 2. Low-Emitting Materials: Verify mastic coatings comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Foster Brand; H. B. Fuller.](#)
 - c. [Knauf Insulation.](#)
 - d. [Vimasco Corporation.](#)
 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Eagle Bridges - Marathon Industries.](#)
 - c. [Foster Brand; H. B. Fuller.](#)
 - d. [Knauf Insulation.](#)

- e. [Mon-Eco Industries, Inc.](#)
 - f. [Vimasco Corporation.](#)
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Color: White.
- 2.5 LAGGING ADHESIVES
- A. Description: Comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Foster Brand; H. B. Fuller.](#)
 - c. [Vimasco Corporation.](#)
 2. [Verify adhesives have a VOC](#) content of 50 g/L or less.
 3. [Verify adhesive complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 5. Service Temperature Range: 0 to plus 180 deg F.
 6. Color: White.
- 2.6 SEALANTS
- A. FSK and Metal Jacket Flashing Sealants:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Eagle Bridges - Marathon Industries.](#)
 - c. [Foster Brand; H. B. Fuller.](#)
 - d. [Mon-Eco Industries, Inc.](#)
 2. Materials are compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.
 6. [Verify sealant has a VOC](#) content of 420 g/L or less.
 7. [Verify sealant complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Foster Brand; H. B. Fuller.](#)
2. Materials are 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.
6. [Verify sealant has a VOC](#) content of 420 g/L or less.
7. [Verify sealant complies with the](#) testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.
 6. ASJ+: All-service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
 7. PSK Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.
- B. Self-Adhesive Outdoor Jacket (Asphaltic): Minimum 10-mil-thick, 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 white stucco-embossed aluminum-foil facing.
 1. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller.
 - b. [MFM Building Products Corp.](#)
 - c. [Polyguard Products, Inc.](#)
 - d. 3M.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Alpha Associates, Inc.](#)

2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [3M Industrial Adhesives and Tapes Division.](#)
 - b. [Avery Dennison Corporation, Specialty Tapes Division.](#)
 - c. [Ideal Tape Co., Inc., an American Biltrite Company.](#)
 - d. [Knauf Insulation.](#)
 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 C1136.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [3M Industrial Adhesives and Tapes Division.](#)
 - b. [Avery Dennison Corporation, Specialty Tapes Division.](#)
 - c. [Ideal Tape Co., Inc., an American Biltrite Company.](#)
 - d. [Knauf Insulation.](#)
 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. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [3M Industrial Adhesives and Tapes Division.](#)
 - b. [Avery Dennison Corporation, Specialty Tapes Division.](#)
 - c. [Ideal Tape Co., Inc., an American Biltrite Company.](#)
 - d. [Knauf Insulation.](#)
 - e. [Sekisui Voltek, LLC.](#)
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.

2.11 SECUREMENTS

A. Bands:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Johns Manville; a Berkshire Hathaway company.](#)
 - b. [RPR Products, Inc.](#)
2. Stainless Steel: ASTM A240/A240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal.
3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing 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:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) [AGM Industries, Inc.](#)
 - 2) [Gemco.](#)
 - 3) [Midwest Fasteners, Inc.](#)
 - 4) [Nelson Stud Welding.](#)
2. 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.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel, or aluminum, or stainless steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

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:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [C & F Wire Products.](#)
- b. [Johns Manville; a Berkshire Hathaway company.](#)
- c. [RPR Products, Inc.](#)

2.12 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC in accordance with ASTM D1784, 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 in accordance with ASTM B209, 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 in accordance with ASTM A240/A240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents, unless otherwise approved by the engineer-of-record.

- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
 - H. Install insulation with least number of joints practical.
 - I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
 - K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
 - L. Cut insulation in a manner to avoid compressing insulation.
 - M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
 - N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- 3.4 PENETRATIONS
- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install

- insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- 3.5 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION
- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
- B. Comply with manufacturer's written installation instructions.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, but no less than 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

- b. On duct sides with dimensions larger than 18 inches, 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 overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent 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 consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- C. 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, but no less than 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.

- e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- 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.

3.7 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 "Exterior Painting" and "Interior Painting."
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- 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.

3.8 DUCT INSULATION SCHEDULE, GENERAL

- A. Items Not Insulated:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1-2019.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums and casings.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Factory-insulated access panels and doors.
 - 8. Returns ducts inside return air plenum or exposed return ducts in conditioned spaces.
 - 9. Exposed ductwork between diffusers or registers and the air volume terminal unit or local heating/cooling unit located within the space served. Where air volume terminal or local heating/cooling unit is located outside the space served, insulate up to wall of space served.

DUCT AND PLENUM INSULATION SCHEDULE

- B. Provide insulation materials, minimum R-value, minimum thicknesses, and field applied jacket as identified below.
- C.

Duct & Duct Mounted Equipment Location – Duct is used interchangeably with plenum	D. Minimum R-Value As Installed and Minimum Insulation Thickness	E. Insulation Type	Field Applied Jacket
Supply ducts, return ducts, energy recovery exhaust ducts, duct mounted coils, and supply fans exterior to building.	R-12, 3"	Rigid Glass-Fiber Board w/ FSK. Taper insulation 1/8" per foot up from minimum to shed water.	Self-adhesive outdoor jacket
Supply, return, and energy recovery exhaust ducts outside of building insulation and not exposed to weather (including attics or plenums above insulated ceilings, parking garages, and crawl spaces)	R-12, 3"	Glass-Fiber Blanket w/ FSK	None
Outside air, relief air, and exhaust air ductwork between building envelope and equipment connection or isolation damper	R-12, 3"	Mechanical Room - Rigid Glass Fiber Board w/ FSK	None
	R-12, 3"	All other locations - Glass Fiber Blanket w/ FSK	None
Supply ducts, return ducts, energy recovery exhaust ducts, duct mounted coils, back of supply outlets, supply outlet plena, and supply fans in unconditioned spaces - includes above ceiling in non-return air plenums and shafts.	R-8, 2"	Glass-Fiber Blanket w/ FSK	None
Supply ducts, return ducts, relief ducts, energy recovery exhaust ducts, and duct mounted coils in mechanical rooms.	R-8, 2"	10 Feet or Greater Above Finished Floor - Glass-Fiber Blanket w/ FSK	None
		Less than 10 Feet Above Finished Floor - Rigid Glass-Fiber Board w/ FSK	None
Supply ducts, duct mounted coils, and supply fans in indirectly conditioned spaces (return air ceiling plenum) with or without exposed roofs above.	R-1.9, 1.5"	Glass-Fiber Blanket w/ FSK	None
Supply ducts and duct mounted coils exposed in occupied spaces between heating and cooling unit or shaft up to terminal box inlet or wall of space served.	R-1.9, 1.5"	Rigid or Semi-Rigid Glass-Fiber Board w/ FSK	None
Exhaust air ducts exterior to building	R-6, 2"	Rigid Glass-Fiber Board w/ FSK. Taper insulation 1/8" per foot up from minimum to shed water	Self-adhesive outdoor jacket

Interior exhaust air ducts within 10 feet of exterior openings		R-6, 2"	Glass-Fiber Blanket w/ FSK	None
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END OF SECTION 23 07 13

SECTION 23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes the following scope for the new equipment provided as part of this project scope:
 - 1. DDC system for monitoring and controlling of HVAC systems including control components for the following:
 - a. Energy recovery ventilator.
 - b. Split system cooling systems.
 - c. Fin-tube perimeter heat (existing to be integrated with new room HVAC systems).
 - 2. This Section shall provide electric circuit breakers and all power wiring from normal and standby power panels to each DDC system component.
 - 3. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation;
 - a. Ductwork automatic control dampers, airflow stations and terminal unit controllers.
 - 4. Installation of products furnished under other sections;
 - a. Packaged equipment thermostats and duct static pressure sensors.
 - 5. Integration with equipment furnished by other sections with packaged controls;
 - a. Packaged split system controls
 - b. Crossflow sensors provided on VAV terminal units.
 - c. Duct mounted smoke detectors.
 - d. Packaged dehumidifier controls (general alarm only)
 - 6. Control dampers and actuators for DDC systems.
 - 7. Sequence of operations outlined on the drawings.
 - 8. Outline required controls infrastructure for future integration of existing VAV and Fan Powered VAV terminal boxes.
- B. Related Sections:

1. Division 26 and Division 27 for power and communications cabling, raceways, pathways, power and communication component identification requirements.

1.3 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. BACnet Specific Definitions:
 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
 2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
 4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
 5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.
- D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are included: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- E. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- F. COV: Change of value.
- G. Cv: Design valve coefficient.
- H. DDC: Direct-digital control.
- I. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work.
- J. Digital: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Binary" is sometimes used interchangeably with "Digital" to indicate a two-state signal.
- K. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
- L. E/P: Voltage to pneumatic.

- M. Ethernet: Local area network based on IEEE 802.3 collection of standards. Trademark for a system of exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables. Ethernet is a registered trademark of Digital Equipment Corporation, Intel, and Xerox and is the basis for IEEE 8802-3
- N. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- O. HLC: Heavy load conditions.
- P. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Binary," (BI) and (BO) is sometimes used interchangeably with "Digital," (DI) and (DO) respectively.
- Q. I/P: Current to pneumatic.
- R. Internet Protocol (IP): Global network that connects operator workstations and other host computers, servers and other devices to share information.
- S. LAN: Local area network.
- T. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- U. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- V. Modbus TCP/IP: An open protocol for exchange of process data.
- W. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- X. MTBF: Mean time between failures.
- Y. NBR: Nitrile butadiene rubber.
- Z. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers that communicates on peer-to-peer network for transmission of global data.
- AA. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- BB. PC: Personal computer
- CC. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- DD. PID: Proportional plus integral plus derivative
- EE. POT: Portable operator terminal.

- FF. PTFE: Polytetrafluoroethylene
- GG. PUE: Performance usage effectiveness.
- HH. RAM: Random access memory.
- II. RF: Radio frequency.
- JJ. Router: Device connecting two or more networks at network layer.
- KK. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- LL. RTD: Resistance temperature detector
- MM. TCP/IP: Transport control protocol/Internet protocol.
- NN. UPS: Uninterruptible power supply.
- OO. USB: Universal Serial Bus.
- PP. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- QQ. VAV: Variable air volume.
- RR. WLED: White light emitting diode.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. General
 - 1. Provide shop drawings and other submittals on all hardware, software and installation to be provided. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.
- B. Multiple Submissions:
 - 1. If multiple submissions are required to execute work within schedule, submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
 - 2. Clearly identify each submittal requirement and in which submission the information will be provided.
 - 3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.
- C. Product Data: For each type of product include the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors affecting performance.
5. Bill of materials, technical data and installation and maintenance instructions indicating manufacturer and extended model number for each unique product including but not limited to the following:
 - a. Workstation.
 - b. Gateways.
 - c. Routers.
 - d. Protocol analyzers.
 - e. DDC controllers and control panels.
 - f. Enclosures.
 - g. Electrical power devices.
 - h. Accessories.
 - i. Instruments.
 - j. Control dampers and actuators.
 - k. Interface equipment.
 - l. Transducers/transmitters
 - m. Sensors (including accuracy data)
 - n. Actuators
 - o. Valves
 - p. Relays/switches
 - q. Control panels
 - r. Power supply
 - s. Battery Backup
 - t. Operator interface equipment
 - u. Wiring
6. When manufacturer product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information. General catalogs shall not be accepted as datasheets to fulfill submittal requirements.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

D. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, gateway and DDC controller.
2. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.

6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
 7. Description of operator interface to alphanumeric and graphic programming.
 8. Description of each network communication protocol.
 9. Description of system database, including all data included in database, database capacity and limitations to expand database.
 10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
 11. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
 12. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system
- E. Shop Drawings:
1. General Requirements:
 - a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
 - c. Drawings Size: 11 inch x 17 inch minimum, 48 inch x 36 inch maximum.
 2. Include plans, elevations and mounting details.
 3. Include details of product assemblies. Indicate dimensions, weights, loads, clearance required, recommended method of field assembly, components, and location and size of each field connection.
 4. Detail means of vibration isolation and show attachments to rotating equipment.
 5. Plan Drawings indicating the following:
 - a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
 - b. Room names and numbers with coordinated placement to avoid interference with control products.
 - c. Each desktop workstation, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller.
 - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
 - e. Network communication cable and raceway routing.
 - f. Information, drawn to scale, minimum 0.25 inch = 1 foot - 0 inches.
 - g. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services before installation.
 6. Schematic drawings for each controlled HVAC system indicating the following:
 - a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve.
 - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number. Include:

- 1) Point description: Provide building designation, system type, equipment type, engineering units, and functionality; include a description of its physical location.
 - 2) Expected range (upper and lower limit).
 - 3) Type of point (e.g. AI, AO, DI, DO, Network, Virtual, Calculated).
- c. A graphic showing location of control I/O in proper relationship to HVAC system.
 - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
 - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
 - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
 - g. Descriptive narrative of programs to perform sequences of operation. Narrative shall not merely duplicate design sequence of operation.
 - h. Graphic sequence of operation, showing all inputs and output logical blocks.
7. Control panel drawings indicating the following:
- a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
 - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
 - c. Front, rear, and side elevations and nameplate legend.
 - d. Unique drawing for each panel.
 - e. Wiring diagrams.
8. DDC system network riser diagram indicating the following:
- a. Each device connected to network with unique identification for each.
 - b. Interconnection of each different network in DDC system.
 - c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
 - d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
9. DDC system electrical power riser diagram indicating the following:
- a. Each point of connection to field power with requirements (volts, phase, hertz, amperes, connection type) listed for each.
 - b. Each control power supply including associated transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
 - c. Each product requiring power with requirements (volts, phase, hertz, amperes, connection type) listed for each.
 - d. Power wiring type and size, race type, and size for each.
10. Monitoring and control signal diagrams indicating the following:
- a. Control signal cable and wiring between controllers and I/O.
 - b. Point-to-point schematic wiring diagrams for each product.
 - c. Control signal tubing to sensors, switches and transmitters.

- d. Process signal tubing to sensors, switches and transmitters.
11. Color graphics indicating the following:
 - a. Itemized list of color graphic displays to be provided.
 - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
 - c. Intended operator access between related hierarchical display screens.
 - d. Provide description of procedures to access each graphics screen.
- F. System Description:
1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, controller types and applications, gateways, routers and other network devices, and power supplies.
 2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
 3. System and product operation under each potential failure condition including, but not limited to, the following:
 - a. Loss of power.
 - b. Loss of network communication signal.
 - c. Loss of controller signals to inputs and outputs.
 - d. Operator workstation failure.
 - e. Gateway failure.
 - f. Network failure
 - g. Controller failure.
 - h. Instrument failure.
 - i. Control damper and valve actuator failure.
 4. Complete bibliography of documentation and media to be delivered to Owner.
 5. Description of testing plans and procedures.
 6. Description of Owner training.
- G. Delegated-Design Submittal: For DDC system products and installation below.
1. Provide the following documentation showing DDC system complies with performance requirements indicated, including calculations and other documentation confirming compliance:
 - a. Schedule and design calculations for control dampers and actuators.
 - 1) Flow at project design and minimum flow conditions.
 - 2) Face velocity at project design and minimum airflow conditions.
 - 3) Pressure drop across damper at project design and minimum airflow conditions.
 - 4) AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop.
 - 5) Maximum close-off pressure.
 - 6) Leakage airflow at maximum system pressure differential (fan close-off pressure).
 - 7) Torque required at worst case condition for sizing actuator.
 - 8) Actuator selection indicating torque provided.
 - 9) Actuator signal to control damper (open, close or modulate).

- 10) Actuator position on loss of power.
 - 11) Actuator position on loss of control signal.
- b. Schedule and design calculations for control valves and actuators.
- 1) Flow at project design and minimum flow conditions.
 - 2) Pressure-differential drop across valve at project design flow condition.
 - 3) Maximum system pressure-differential drop (pump close-off pressure) across valve at project minimum flow condition.
 - 4) Design and minimum control valve coefficient with corresponding valve position.
 - 5) Maximum close-off pressure.
 - 6) Leakage flow at maximum system pressure differential.
 - 7) Torque required at worst case condition for sizing actuator.
 - 8) Actuator selection indicating torque provided.
 - 9) Actuator signal to control damper (open, close or modulate).
 - 10) Actuator position on loss of power.
 - 11) Actuator position on loss of control signal.
- c. Schedule and design calculations for selecting flow instruments.
- 1) Instrument flow range.
 - 2) Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
 - 3) Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
 - 4) Pressure-differential loss across instrument at Project design flow conditions.
 - 5) Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Product installation location shown in relationship to room, duct, pipe and equipment.
 - b. Control valve installation location shown in relationship to room, duct, pipe, and equipment.
 - c. Structural members to which products will be attached.
 - d. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices and other installed devices.
 - e. Size and location of wall access panels for products installed behind walls and requiring access.
2. Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Ceiling components.
 - b. Size and location of access panels for products installed above inaccessible ceiling assemblies or within walls and requiring access.
 - c. Items penetrating finished ceiling including the following:

- 1) Lighting fixtures.
- 2) Air outlets and inlets.
- 3) Speakers.
- 4) Sprinklers.
- 5) Access panels.
- 6) Motion sensors.
- 7) Pressure sensors.
- 8) Temperature sensors and other DDC control system instruments.

B. Qualification Data:

1. Systems Provider Qualification Data:

- a. Resume of project manager assigned to Project.
- b. Resumes of application engineering staff assigned to Project.
- c. Resumes of installation and programming technicians assigned to Project.
- d. Resumes of service technicians assigned to Project.
- e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building primary function.
- f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
- g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
- h. Owner contact information for past project including name, phone number, and e-mail address.
- i. Contractor contact information for past project including name, phone number, and e-mail address.
- j. Architect and Engineer contact information for past project including name, phone number, and e-mail address.

2. Manufacturer qualification data.
3. Testing agency qualifications data.

C. Product Certificates:

1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.

D. Product Test Reports: For each product that requires testing to be performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For manufacturer warranty.

H. Schedules - Within one month of contract award, provide a schedule of the work indicating the following:

1. Intended sequence of work items
 - a. Start dates of individual work items

- b. Duration of individual work items
 - c. Planned delivery dates for major material and equipment and expected lead times.
 - d. Milestones indicating possible restraints on work by other trades or situations.
2. Provide monthly written status reports indicating work completed and revisions to delivery dates including software development. An updated project schedule shall be included.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Upon completion of installation and prior to final acceptance submit three copies of record (as-built) documents in accordance with Division 01. In addition to items specified in Division 01 include the following:
 1. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format and as ANSI B (11 inch x 17 inch) prints.
 2. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 3. As-built versions of submittal Product Data.
 4. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
 5. Operator manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
 6. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 7. Engineering, installation, and maintenance manuals that explain how to:
 - a. Design and install new points, panels, and other hardware.
 - b. Perform preventive maintenance and calibration.
 - c. Debug hardware problems.
 - d. Repair or replace hardware.
 8. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
 9. Backup copy of graphic files, programs, and database on electronic media such as DVDs or on an external hard drive.
 10. List of recommended spare parts with part numbers and suppliers.
 11. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 12. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 13. Licenses, guarantees, and warranty documents.
 14. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
 15. Owner training materials.
 16. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturer recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.
- C. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
 - 1. Room Temperature Sensor and Transmitter: One.

1.9 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
 - 1. National Electric Code (NEC)
 - 2. International Building Code (IBC)
 - 3. International Mechanical Code (IMC)
 - 4. Local codes

1.10 QUALITY ASSURANCE

- A. DDC System Manufacturer Qualifications:
 - 1. Nationally recognized manufacturer of DDC systems and products.
 - 2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
 - 3. DDC systems and products that have been successfully tested and in use on at least five past projects.
- B. DDC System Provider Qualifications:
 - 1. Installer shall have an established working relationship with BAS manufacturer of not less than three years and shall be an authorized representative of, and trained by, DDC system manufacturer.
 - 2. In-place facility located within 50 miles of Project.
- C. Testing Agency Qualifications: Company Member of International Electrical Testing Association (NETA).
 - 1. Testing Agency Field Supervisor: Certified by NETA to supervise on-site testing.

1.11 WARRANTY

- A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
 - 1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.

2. Include updates or upgrades to software and firmware to resolve deficiencies. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve the contractor identified software deficiencies at no charge during warranty period. Notify owner of upgrades for functional enhancements available for purchase as part of in-warranty service agreements.
 - a. Install updates only after receiving Owner written authorization.
3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner warranty service request.
4. Work shall have a single warranty date, even if the owner receives beneficial use due to early system start-up. Where specified work is split into multiple contracts or a multiphase contract, each contractor phase shall have a separate warranty start date and period.
5. Instrumentation shall be covered by manufacturer transferable "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

PART 2 PRODUCTS

2.1 DDC SYSTEM MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Siemens Industry, Inc., Building Technologies Division.
- B. Inclusion on this list does not guarantee acceptance of products or installation. DDC system shall comply with the terms of this specification and the project drawings.
- C. Provide operator workstation software, controller software, and custom application programming language, building controllers, programmable application controllers and application specific controllers from only one of the listed manufacturers.
- D. Other products specified herein (such as sensors, valves, dampers and actuators) need not be manufactured by the above manufacturers.
- E. Provided system shall be capable of integrating existing to remain building application controllers.

2.2 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
 1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
 2. The operator workstation shall provide for overall system supervision and configuration, graphical user interface, management report generation and alarm annunciation.
 3. Performance Monitoring: The BAS will provide the specified performance monitoring functionality, including required monitoring points and performance metrics, improved through system accuracy, data acquisition and data management capabilities, and required graphical and data displays.
 4. Event Response: The BAS will provide operational changes based on event response.

- 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. Ownership of Proprietary Material - Project-specific software and documentation shall become owner property. This includes but is not limited to the following:
 - 1. Graphics
 - 2. Record drawings
 - 3. Database
 - 4. Application programming code
 - 5. Documentation
- D. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site. Spare parts shall be available for at least five years after completion of this contract.

2.3 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall compose an open protocol BAS. Controller and operator interface communication shall conform to open-protocol body conformance and/or certification requirements.
- B. Each controller shall have a communication port.
- C. Where indicated on the project drawings, remote buildings or sites shall be connected to the enterprise network to allow for communication with each controller on the network.
- D. Network operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to the BAS shall allow the operator to interface with each networked controller as if directly connected. BAS information such as data, status, reports, system software, and custom programs shall be viewable and editable.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be available on the network. Program and test all cross-controller links required to execute specified BAS operation. An authorized operator shall be able to manage, maintain, and access the BAS network of controllers.
- E. Workstations, building control panels and controllers with real-time clocks shall use the open-protocol time synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time.

2.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional to select components and design DDC system to satisfy system performance objectives:
 - 1. DDC system shall manage HVAC systems.
 - 2. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
 - 3. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
 - 4. DDC system shall operate while unattended by an operator and through operator interaction.

5. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- D. DDC System Speed:
 1. Response Time of Connected Input/Output:
 - a. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
 - b. DI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
 - c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
 - d. DO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
 2. Display of Connected I/O:
 - a. Analog point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
 - b. Binary point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
 - c. Alarms of analog and digital points connected to DDC system shall be displayed within 15 seconds of activation or change of state.
 - d. Graphic display shall indicate current data within 10 seconds and shall refresh within eight seconds.
 - e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
 3. Device Reaction Performance:
 - a. Devices shall react to a digital command within two seconds.
 - b. Devices shall begin to react to an analog command within two seconds.
 4. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control.

5. Performance: Programmable controllers shall be able to completely execute DDC control system PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
 6. Multiple Alarm Annunciation: Each work station on the network shall receive alarms within 5 seconds of other workstations.
- E. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions. Calculate bandwidth usage and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- F. DDC System Data Storage:
1. Local Storage:
 - a. Provide external drive with data storage indicated using IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.
- G. DDC Data Access:
1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system for functional operation of DDC system.
 2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
- H. Future Expandability:
1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.
 2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
 3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.
- I. Input Point Displayed Accuracy and Control Accuracy:
1. Input point displayed values shall meet following end-to-end overall system accuracy and control accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion. Where multiple accuracies are listed, values labeled STD are for standard building controls and values labeled MV are for sensors used for measurement and verification.

Temperature and Humidity Sensors							
Variable	Sensor Value Type	Sensor Type or Calculation Method	Range	End to End Accuracy - Plus or Minus	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control - Plus or Minus
Ambient dry-bulb temperature	AI	Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies.	-20 deg F to 120 deg F	1.0 deg F (STD) 0.35 deg F (MV)	1	10	2 deg F
Ambient average daily outdoor temperature	Calculated	Average of instantaneous measured values	—	0.35 deg F (MV)	1	10	0.35 deg F
Ambient wet-bulb temperature	AI	Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies	-20 deg F to 120 deg F	3.0 deg F (STD) 0.5 deg F (MV)	1	10	3 deg F
Ambient dewpoint temperature	AI	Chilled mirror, infrared, Capacitive Locate in weather station or ventilated enclosure in fully shaded location away from thermal mass bodies	10 deg F to 100 deg F	3 deg F	1	10	3 deg F
Zone (space) air Temperature	AI	10000 ohm thermistor or 1000 ohm RTD	30 deg F to 100 deg F	1.0 deg F (STD) 0.5 deg F (MV)	1	1	1 deg F
Zone (space) wet-bulb temperature	Calculated	Calculated from temperature and relative humidity	—	2 deg F	1	1	2 deg F
Zone (space) and duct relative humidity (RH)	AI	—	20 percent to 80 percent	5 percent RH	1	1	5 percent RH
Zone (space) and duct dewpoint temperature	Calculated	Chilled mirror, infrared, Capacitive	10 deg F to 100 deg F	1.8 deg F	1	1	1.8 deg F
Ducted air temperature	AI	10000 ohm thermistor or 1000 ohm RTD	45 deg F to 140 deg F	1.0 deg F	1	1	1 deg F
Ducted air wet-bulb temperature	Calculated	Calculated from temperature and relative humidity	—	2 deg F	1	1	2 deg F
Air-handling unit supply air temperature	AI	10000 ohm thermistor or 1000 ohm RTD	45 deg F to 120 deg F	0.35 deg F	1	10	1 deg F
Air-handling unit mixed air temperature	AI	Locate in air handler mixed air section; to minimize effects of stratification use averaging sensor	40 deg F to 100 deg F	0.35 deg F	1	10	1 deg F
Air-handling unit return air temperature	AI	Locate upstream of air handler return air damper	60 deg F to 90 deg F	0.35 deg F	1	10	1 deg F

Pressure Sensors							
Variable	Sensor Value Type	Sensor Type or Calculation Method	Range	End-to End Accuracy - Plus or Minus	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control - Plus or Minus
Air Pressure (ducts)	AI	Variable capacitance	0 to 8 in. wg	0.1 in. wg	1	1	0.1 in. wg
Air Pressure (space)	AI	Variable capacitance	-0.35 to 0.35 in. wg	0.01 in. wg	1	1	0.005 in. wg

Flow Sensors							
Variable	Sensor Value Type	Sensor Type or Calculation Method	End-to End Accuracy - Plus or Minus	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control - Plus or Minus	
Fan airflow rate	AI	Vortex shedding sensor on fan inlet	5 percent of reading down to 150 ft/min	1	1	5 percent of reading down to 150 ft/min	
Total air-handling unit supply airflow	Calculated	Sum of measured values	5 percent	1	10	5 percent	
Airflow rate (duct and equipment except terminal units measuring stations)	AI	Electronic or differential pressure	5 percent of reading down to 150 ft/min	1	1	5 percent of reading down to 150 ft/min	
Airflow (terminal units)	AI	Electronic or differential pressure	10 percent of reading	1	1	10 percent of reading	
Airflow (pressurized spaces)	AI	Electronic or differential pressure	3 percent of reading	1	1	3 percent of reading	

Air Handling Unit Damper Position and Outdoor Air Flow Calculation							
Variable	Sensor Value Type	Sensor Type or Calculation Method	Range	End-to End Accuracy	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control
Air-handling unit outdoor air and return air demanded damper position	AI	Virtual point that commands the damper position	0 percent to 100 percent	N/A	1	10	0.1 percent
Air-handling unit percentage outdoor air	Calculated	See Note 1	0 percent to 100 percent	N/A	1	1	0.1 percent

Note 1: When temperature difference between OAT and AHU RAT is greater than 5 deg F, calculate percent OA as follows:
 percent OA = (AHU MAT - AHU RAT)/(OAT - AHU RAT)

Where: MAT = Mixed air Temperature, RAT = Return Air Temperature, OAT = Outdoor Ambient Air Temperature

Gas Sensors							
Variable	Sensor Value Type	Sensor Type or Calculation Method	Range	End-to End Accuracy - Plus or Minus	Refresh Interval (min)	Trend Interval (min)	Accuracy for Control - Plus or Minus
Carbon dioxide	AI	Non-dispersive infrared sensor technology	0 to 2000 ppm	Greater of 5 percent of reading or 50 ppm (STD) Greater of 3 percent of reading or 40 ppm (MV)	1	1	5 percent of reading
Carbon monoxide	AI	Electrochemical sensor	0 to 100 ppm	5 ppm	1	1	5 percent of reading

- J. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:
1. Current:
 - a. Milliamperes: Nearest 1/10th of a milliampere.
 - b. Amperes: Nearest 1/10th of an ampere up to 100 Amp; nearest ampere for 100 Amp and more.
 2. Energy:
 - a. Electric Power:
 - 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
 - 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
 - 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
 - b. Thermal, Rate:
 - 1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.
 - 2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.
 - c. Thermal, Usage:
 - 1) Heating: For Btu, nearest 10 Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.
 - 2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.
 3. Flow:
 - a. Air: Nearest cfm through 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
 - b. Water: Nearest gpm through 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
 - c. Steam: Nearest lbs/hr through 1000 lbs/hr; nearest 10 lbs/hr above 1000 lbs/hr.
 4. Gas:
 - a. Carbon Dioxide (ppm): Nearest ppm.
 5. Moisture (Relative Humidity):
 - a. Relative Humidity (Percentage): Nearest 1 percent.

6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.
 7. Speed:
 - a. Rotation (rpm): Nearest 1 rpm.
 - b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.
 8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
 9. Pressure:
 - a. Air, Ducts and Equipment: Nearest 1/10th in. w.c.
 - b. Space: Nearest 1/100th in. w.c.
 - c. Steam: Nearest 1/10th psig through 100 psig; nearest psig above 100 psig.
 - d. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig.
 10. Temperature:
 - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
 - b. Outdoor: Nearest degree.
 - c. Space: Nearest 1/10th of a degree.
 - d. Chilled Water: Nearest 1/10th of a degree.
 - e. Condenser Water: Nearest 1/10th of a degree.
 - f. Heating Hot Water: Nearest degree.
 - g. Heat Recovery Runaround: Nearest 1/10th of a degree.
 - h. Steam: Nearest degree.
 11. Vibration: Nearest 1/10th in/s.
 12. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.
- K. Environmental Conditions for Controllers, Gateways, and Routers:
1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
 - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated by product and application.
 2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors: Type 4X.
 - b. Indoors: Type 2.
 - c. Mechanical Equipment Rooms: Type 12.
 - d. Localized Areas Exposed to Wash Down: Type 4X.
 - e. Within Duct Systems and Air-Moving Equipment: Type 4.
 - f. Hazardous Locations: Explosion-proof rating for condition.

L. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated to meet specific requirements of the instrument and application.
 2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors: Type 4X.
 - b. Indoors: Type 2.
 - c. Mechanical Equipment Rooms: Type 12.
 - d. Localized Areas Exposed to Washdown: Type 4X.
 - e. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
 - f. Hazardous Locations: Explosion-proof rating for condition.
- M. Electric Power Quality:
1. Power-Line Surges:
 - a. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
 - b. Do not use fuses for surge protection.
 - c. Test protection in the normal mode and in the common mode, using the following two waveforms:
 - 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
 - 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.
 2. Power Conditioning:
 - a. Protect DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
 - 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
 - 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
 - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
 - 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.
- N. Backup Power Source:
1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.
- O. Continuity of Operation after Electric Power Interruption:
1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.5 SYSTEM ARCHITECTURE

- A. System architecture shall consist of no more than three levels of LANs.
1. Level one LAN shall connect network controllers and operator workstations.
 2. Level one or Level two LAN shall connect programmable application controllers to other programmable application controllers and to network controllers.
 3. Level two or Level three LAN shall connect application-specific controllers to other application-specific controllers, to programmable application controllers and to network controllers.
- B. Provide data transfer and communication speed recommended by the BAS manufacturer subject to the following minimum requirements:
1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
 2. LAN Connecting Programmable Application Controllers: 1000 kbps.
 3. LAN Connecting Application-Specific Controllers: 115,000 bps.
- C. DDC system shall consist of dedicated and separated LANs that are not shared with other building systems and not shared with tenant data and communication networks.
- D. System architecture shall be modular and have inherent ability to expand with no impact to performance indicated.
- E. System architecture shall perform modifications without having to remove and replace existing network equipment.
- F. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all DDC system LANs.
- G. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.
- H. Upon loss of communication from a controller to the network or between paired controllers, an alarm shall be initiated at the DDC system head end computer.

2.6 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator able to access entire DDC system through any of multiple means including, but not limited to, the following:
 - 1. Mobile device and application with secured wireless connection through LAN router or cellular data service.
 - 2. Remote connection through web access.
- B. Make access to system, regardless of operator means used, transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable workstation. Network port easily accessible, properly protected, clearly labeled, and installed at the following locations:
 - 1. Main electric room
- D. Mobile Device (Tablet and Smart Phone):
 - 1. Connect Contractor-furnished mobile devices to system through a wireless router connected to LAN.
 - 2. Able to communicate with any DDC controller connected to DDC system using dedicated application and secure web access.
- E. Critical Alarm Reporting:
 - 1. Send operator-selected critical alarms to notify operator of critical alarms that require immediate attention.
 - 2. Send alarm notification to multiple recipients that are assigned for each alarm.
 - 3. Notify recipients by any or all means, including email, text message, and prerecorded phone message to mobile and landline phone numbers.
- F. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any of operator interfaces indicated.

2.7 NETWORKS

- A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:
 - 1. ATA 878.1, ARCNET.
 - 2. CTA-709.1-D.
 - 3. IP.
 - 4. ISO/IEC/IEEE 8802-3, Ethernet.
- B. Acceptable networks for connecting programmable application controllers include the following subject to meeting performance specified:
 - 1. ATA 878.1, ARCNET.
 - 2. CEA-709.1-C.
 - 3. IP.
 - 4. IEEE 8802-3, Ethernet.

- C. Acceptable networks for connecting application-specific controllers include the following subject to meeting performance specified:
1. ATA 878.1, ARCNET.
 2. CEA-709.1-C.
 3. EIA-485A.
 4. IP.
 5. IEEE 8802-3, Ethernet.

2.8 NETWORK COMMUNICATION PROTOCOL

- A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.
- B. ASHRAE 135 Protocol:
1. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
 2. Gateways required for integration shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
 3. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

2.9 SYSTEM SOFTWARE

- A. System Software Minimum Requirements:
1. Real-time multitasking and multiuser 32- or 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
 2. Acceptable operating systems are Windows, the latest Windows Server release, Linux, and UNIX. Operating system shall be capable of operating DOS and Microsoft Windows applications. The operating system also shall support the use of other common software applications. Examples include Microsoft Excel, Microsoft Access, or other SQL database software.
 3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
 4. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
 5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
 6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.
- B. Operator Interface Software:
1. Minimize operator training through use of English language prorating and English language point identification.

2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Security Access:
 - a. All system security data shall be stored in an encrypted format.
 - b. Operator access to DDC system shall be under password control.
 - c. Each operator shall be required to log on to the system with a username and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. An alphanumeric password shall be field assignable to each operator. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object.
 - 1) Operator log-off shall be a manual operation or automatic if no keyboard or mouse activity is detected. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
 - 2) Operator sign-on and sign-off activity shall be recorded and sent to printer.
 - d. Operator password shall be same regardless of which computer or other interface means is used.
 - e. Additions or changes made to passwords shall be updated automatically.
 - f. Software shall have at least five access levels.
 - g. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
 - h. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.
4. Data Segregation:
 - a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
 - b. Include at least 32 segregation groups.
 - c. Segregation groups shall be selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
 - d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
 - e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
 - f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.
5. Operators shall be able to perform commands including, but not limited to, the following:
 - a. Start or stop selected equipment.
 - b. Adjust set points.
 - c. Add, modify, and delete time programming.
 - d. Enable and disable process execution.
 - e. Lock and unlock alarm reporting for each point.
 - f. Enable and disable totalization for each point.

- g. Enable and disable trending for each point.
 - h. Override control loop set points.
 - i. Enter temporary override schedules.
 - j. Define holiday schedules.
 - k. Change time and date.
 - l. Enter and modify analog alarm limits.
 - m. Enter and modify analog warning limits.
 - n. View limits.
 - o. Enable and disable demand limiting.
 - p. Enable and disable duty cycle.
 - q. Display logic programming for each control sequence.
6. Reporting:
- a. Generated automatically and manually.
 - b. Sent to displays, printers and disk files.
 - c. Types of Reporting:
 - 1) General listing of points.
 - 2) List points currently in alarm.
 - 3) List of off-line points.
 - 4) List points currently in override status.
 - 5) List of disabled points.
 - 6) List points currently locked out.
 - 7) List of items defined in a "Follow-Up" file.
 - 8) List weekly schedules.
 - 9) List holiday programming.
 - 10) List of limits and deadbands.
7. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

- 1. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while online. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
- 2. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least ten levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
- 3. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
- 4. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.

5. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
6. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
7. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
8. Graphics are to be online programmable and under password control.
9. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
10. Graphics shall also contain software points.
11. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
12. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
13. Display operator accessed data on the monitor.
14. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
15. Include operator with means to directly access graphics without going through penetration path.
16. Dynamic data shall be assignable to graphics.
17. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
18. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
19. Points shall be dynamic with operator adjustable update rates on a per point basis from one second to over a minute.
20. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
 - a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
 - b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
 - c. Keyboard equivalent shall be available for those operators with that preference.
21. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
22. Help Features:
 - a. On-line context-sensitive help utility to facilitate operator training and understanding. Provide a context sensitive, online help system to assist the operator in operating and editing the system. Online help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.

- b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation. If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.
 - c. Available for Every Menu Item: Index items for each system menu item.
23. Graphic generation software:
- a. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
 - b. Furnish a complete library of standard HVAC equipment graphics including but not limited to chillers, boilers, air handlers, terminal units, chilled beams, fan-coils, unit ventilators, fans, coils, filters, dampers, valves, piping, pumps, ductwork and electrical symbols similar to those indicated on the design drawings. The library shall be furnished in a file format compatible with the graphics generation package program.
 - c. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:
 - 1) Define background screens.
 - 2) Define connecting lines and curves.
 - 3) Locate, orient and size descriptive text.
 - 4) Define and display colors for all elements.
 - 5) Establish correlation between symbols or text and associated system points or other displays.
- D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
- 1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
 - 2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
 - a. Room layouts with room identification and name.
 - b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
 - c. Location and identification of each hardware point being controlled or monitored by DDC system.
 - 3. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation and control logic diagram.
 - 4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
 - 5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways, operator workstations and other network devices.
- E. Customizing Software:

1. Provide software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The BAS shall be fully operable while custom routines are edited, compiled, and downloaded.
2. Software shall allow online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability software:
 - a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.
 - b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
 - c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics. The system shall automatically monitor the operation of all work-stations, printers, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
 - d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
 - e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
 - f. Point related change capability shall include the following:
 - 1) System and point enable and disable.
 - 2) Run-time enable and disable.
 - 3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
 - 4) Assignment of alarm and warning limits.
 - g. Application program change capability shall include the following:
 - 1) Enable and disable of software programs.
 - 2) Programming changes.
 - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.
4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.

6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
 - a. Proportional control (P).
 - b. Proportional plus integral (PI).
 - c. Proportional plus integral plus derivative (PID).
 - d. Adaptive and intelligent self-learning control.
 - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
 - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
 7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
 8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
 9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
 10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.
- F. Alarm Handling Software:
1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.
 2. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
 3. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
 4. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
 5. Alarms display shall include the following:
 - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
 - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
 - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-XXXX."
 - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
 6. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
 7. Send e-mail alarm messages to designated operators.
 8. Send e-mail, page, text and voice messages to designated operators for critical alarms.
 9. Alarms shall be categorized and processed by class.
 - a. Class 1:

- 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
 - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
 - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
- b. Class 2:
- 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
 - 2) Acknowledgement may be through a multiple alarm acknowledgment.
- c. Class 3:
- 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
 - 2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
 - 3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
 - 4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.
- d. Class 4:
- 1) Routine maintenance or other types of warning alarms.
 - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
10. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
11. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.

G. Reports and Logs:

1. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval and date. Report data shall be archived on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.
2. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
3. Each report shall be definable as to data content, format, interval and date.
4. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation for historical reporting.

5. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
- H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
1. All I/O: With current status and values.
 2. Alarm: All current alarms, except those in alarm lockout.
 3. Disabled I/O: All I/O points that are disabled.
 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
 5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
 6. Logs:
 - a. Alarm history.
 - b. System messages.
 - c. System events.
 - d. Trends.
- I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.
- J. Standard Trends:
1. Trend all I/O point present values, set points, and other parameters indicated for trending.
 2. Trends shall be associated into groups, and a trend report shall be set up for each group.
 3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 percent of DDC controller buffer limit, or by operator request, or by archiving time schedule.
 4. Preset trend intervals for each I/O point after review with Owner.
 5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
 6. When drive storage memory is full, most recent data shall overwrite oldest data.
 7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.
- K. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
1. The operator shall be able to define a custom trend log for any data object in the system. Trend data shall be sampled and stored on the building controller panel, be archived on the hard disk, and be retrievable for use in spreadsheets and standard database programs. Trend data shall be exportable in a standard electronic format (.xls, .csv, .xml) for analysis external to the BAS.
 2. Each trend shall include interval, start time, and stop time.
 3. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation hard drives.
 4. Data shall be retrievable for use in spreadsheets and standard database programs.
- L. Alarm Event Log:
1. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.

- M. Group Trend Time Series Plots:
1. Provide user-selectable Y points.
 2. Provide user-editable titles, point names, and Y axis titles.
 3. Individual trended points shall be able to be grouped in groups of up to four points per plot with up to four plots per page.
- N. X-Y Trend Plots: The user shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.
1. User-selectable X and Y trend inputs.
 2. User editable titles, point names and X and Y axis titles.
 3. User-selectable time period options:
 - a. 1-day 24-hour period.
 - b. 1-week 7-day period.
 - c. 1-month period, with appropriate days for the month selected; or
 - d. 1-year period.
 4. User-selectable display of up to 6 plots per screen in 2 columns.
- O. Programming Software:
1. Include programming software to execute sequences of operation indicated.
 2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
 3. Programming software shall be any of the following:
 - a. Graphic Based: Programming using a library of function blocks made from preprogrammed code designed for DDC control systems.
 - 1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
 - 2) Programming tools shall be viewable in real time to show present values and logical results of each function block.
 - b. Menu Based: Programming done by entering parameters, definitions, conditions, requirements and constraints.
 - c. Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.
 4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.
- P. System Applications
1. Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:
 - a. Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each building controller. This database shall be

updated whenever a change is made in any system panel. The storage of these data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first work station to detect the loss shall automatically restore the database for that panel. This capability may be disabled by the operator.

- b. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

Q. Database Management Software:

1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
 - a. Backup.
 - b. Purge.
 - c. Restore.
4. Database management software shall support the following:
 - a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
 - b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
 - c. Backup: Include means to create a database backup file and select a storage location.
 - d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.
5. Database management software shall include information of current database activity, including the following:
 - a. Ready.
 - b. Purging record from a database.
 - c. Action failed.
 - d. Refreshing statistics.
 - e. Restoring database.
 - f. Shrinking a database.
 - g. Backing up a database.
 - h. Resetting Internet information services.
 - i. Starting network device manager.
 - j. Shutting down the network device manager.
 - k. Action successful.
6. Database management software monitoring functions shall continuously read database information once operator has logged on.

7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:
 - a. Allow operator to set and review scan intervals and start times.
 - b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
 - c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
 - d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
 - e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event and audit databases as well as operator proper security access to restore a database.
9. Monitoring settings taskbar shall include the following informational icons:
 - a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
 - b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
 - c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

2.10 DDC CONTROLLERS GENERAL

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Communication. The controller shall reside on a BAS open protocol network using the device-level protocol. Each network of controllers shall be connected to one building controller.
- F. The Controller shall have a network connection for a laptop computer or a portable operator tool.
- G. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- H. Environment Requirements:
 1. All controller hardware shall be suitable for the anticipated ambient conditions.
 2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F mounted in dust proof enclosures.

3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F mounted in waterproof enclosures.
- I. Power and Noise Immunity for All Controllers:
 1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.
- J. Transformer. Power supply for the all controllers must be rated at minimum of 125 percent power consumption and shall be fused or current limiting type.
- K. DDC Controller Spare Processing Capacity:
 1. I/O Capacity. The controller shall contain I/O capacity to control the target system.
 2. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
 - a. Network Controllers: 50 percent.
 - b. Programmable Application Controllers: Not less than 60 percent.
 - c. Application-Specific Controllers: Not less than 70 percent.
 3. Memory shall support DDC controller operating system and database and shall include the following:
 - a. Monitoring and control.
 - b. Energy management, operation and optimization applications.
 - c. Alarm management.
 - d. Historical trend data of all connected I/O points.
 - e. Maintenance applications.
 - f. Operator interfaces.
 - g. Monitoring of manual overrides.
- L. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points. Provide quantities as follows:
 1. Network Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller. Universal points may be used to meet this requirement.
 - b. Minimum Spare I/O Points per Controller: (3) AI; (3) AO; (3) DI; (3) DO. (12) Universal points may be used to meet this requirement.
 2. Programmable Application Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller. Universal points may be used to meet this requirement.
 - b. Minimum Spare I/O Points per Controller: (3) AI; (3) AO; (3) DI; (3) DO. (12) Universal points may be used to meet this requirement.

3. Application-Specific Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller. Universal points may be used to meet this requirement.
 - b. Minimum Spare I/O Points per Controller: (2) AI; (2) AO; (2) DI; (2) DO. (12) Universal points may be used to meet this requirement.

- M. Maintenance and Support: Include the following features to facilitate maintenance and support:
 1. Mount microprocessor components on circuit cards for ease of removal and replacement.
 2. Means to quickly and easily disconnect controller from network.
 3. Means to quickly and easily access connect to field test equipment.
 4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

- N. Input and Output Point Interface:
 1. Controlling and master sensor inputs and controlled device output points shall be hard wired to the associated controller for system and zone level controls. Communication over the network is not acceptable. Sub-master sensors used to reset master sensor setpoints and monitor only input points may connect to network, programmable application and application-specific controllers and communicated to the BAS via the network.
 2. Input/Output System Capacity. The system size shall be expandable to at least twice the number of input/output objects/points required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.
 3. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
 4. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
 5. AIs:
 - a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
 - b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
 - c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
 - d. Signal conditioning including transient rejection shall be provided for each AI.
 - e. Capable of being individually calibrated for zero and span.
 - f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.
 6. AOs:
 - a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
 - b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc to include proper control of output device.
 - c. Capable of being individually calibrated for zero and span.

- d. Analog outputs on building or programmable application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override.
 - e. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
7. DIs:
- a. Controller DIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
 - b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
 - c. DIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
 - d. DIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
8. Pulse accumulation input points shall comply with all requirements of DIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator command.
9. DOs:
- a. Controller DOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
 - 1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
 - 2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.
 - b. DOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
 - c. DOs shall be selectable for either normally open or normally closed operation.
 - d. Include tristate outputs (two coordinated DOs) for control of three-point floating-type electronic actuators without feedback.
10. Tri-State Outputs (Floating Point Control)
- a. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
 - b. Use of floating type devices shall be limited to office, conference and corridor VAV terminal units and associated duct-mounted heating coils, zone dampers, radiation control valves and terminal unit control applications only. Use of floating type devices is not acceptable in laboratory, health care, data center and similar critical zone and system applications.
11. Universal Input/Output:

- a. I/O points shall be the universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application-specific controllers are exempted from this requirement.

2.11 NETWORK CONTROLLERS

- A. Provide quantity of network controllers to achieve performance specified. Each of these controllers shall meet the following requirements.
 1. The DDC system shall be composed of one or more independent, standalone, microprocessor-based network controllers to manage the global strategies described in the software paragraphs.
 2. The network controller shall have memory capacity to support its operating system, database, and programming requirements.
 3. Data shall be shared between network controllers.
 4. The operating system of the network controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object/variable information and allow for central monitoring and alarms.
 5. Controllers that perform scheduling shall have a real-time clock.
 6. The network controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall
 - a. Assume a pre-determined failure mode, and
 - b. Generate an alarm notification.
 7. Controllers shall be full programmable.
- B. Communication:
 1. The network controller shall communicate with networked BAS devices on the network using the protocol-specific communication requirements. Controller-to-controller communication shall be peer-to-peer and not require a master or host server for communication.
 2. The network controller shall be certified, listed by or submitted for testing to a testing laboratory approved by open-protocol body.
 3. Communication.
 - a. Each building controller shall reside on the open-protocol network.
 - b. The controller shall provide a communication port connection or network interface for a portable operator terminal.
 - c. Network routers/repeaters/bridges shall be used to extend communications, change media type, or extend the network in order to ensure proper communication for the entire BAS.
 4. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.
- C. Operator Interface:
 1. Controller shall be equipped with a service communications port for connection to a portable operator workstation or mobile device.
- D. Network controller shall maintain BIOS and programming information in event of a power loss for at least 96 hours.

2.12 PROGRAMMABLE APPLICATION CONTROLLERS

- A. General Programmable Application Controller Requirements:
1. Include quantity of controllers required to achieve performance specified.
 2. Controller shall have enough memory to support its operating system, database, and programming requirements.
 3. Data shall be shared between networked controllers and other network devices.
 4. Capable of standalone operation and shall continue to include control functions without being connected to the network.
 5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
 6. Controllers that perform scheduling shall have a real-time clock.
 7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
 8. Controllers shall be fully programmable.
 9. All controllers shall be tested and certified or listed by an official open-protocol testing laboratory as being compliant with the standardized open-protocol device capabilities.
- B. Communication:
1. Programmable application controllers shall communicate with other devices on network.
 2. Each programmable application controller shall reside on a control network using the device-level protocol.
 3. The controller shall provide a service communication port or network interface using an open-protocol for connection to a portable operator's terminal.
- C. Operator Interface:
1. Controller shall be equipped with a service communications port for connection to a portable operator workstation or mobile device.
- D. Serviceability:
1. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 2. Programmable application controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.13 APPLICATION-SPECIFIC CONTROLLERS

- A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.
1. Capable of standalone operation and shall continue to include control functions without being connected to the network.
 2. Data shall be shared between networked controllers and other network devices.
- B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

- C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator workstation. Connection shall extend to port on space temperature sensor that is connected to controller.
- D. Each application specific controller shall be provided with sufficient I/O capacity to control the target system.
- E. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss for at least 90 days.
- F. Include BACnet communication ports as an equipment OEM standard option, for integration via a single communication cable. BACnet compliant application controllers required for, but not limited to, boilers, boiler plant, chillers, chiller plant and variable-speed drive controllers.
- G. Serviceability:
 - 1. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 - 2. Application specific controller shall maintain BIOS and programming information in event of a power loss.

2.14 CONTROLLER SOFTWARE

- A. General Controller Software Requirements:
 - 1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
 - 2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
 - 3. Control functions shall be executed within controllers using DDC algorithms.
 - 4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.
- B. Security:
 - 1. Operator access shall be secured using individual security passwords and user names.
 - 2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
 - 3. Operator log-on and log-off attempts shall be recorded.
 - 4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.
- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
 - 1. Weekly Schedule:
 - a. Include separate schedules for each day of week.
 - b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
 - c. Each schedule may consist of up to 10 events.

- d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
 2. Exception Schedules:
 - a. Include ability for operator to designate any day of the year as an exception schedule.
 - b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
 3. Holiday Schedules:
 - a. Include capability for operator to define up to 99 special or holiday schedules.
 - b. Schedules may be placed on scheduling calendar and will be repeated each year.
 - c. Operator shall be able to define length of each holiday period.
- D. System Coordination:
 1. Include standard application for proper coordination of equipment.
 2. Application shall include operator with a method of grouping together equipment based on function and location.
 3. Group may then be used for scheduling and other applications.
- E. Digital Alarms:
 1. Each binary point shall be set to alarm based on operator-specified state.
 2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
 1. Each analog object shall have both high and low alarm limits.
 2. Alarming shall be able to be automatically and manually disabled.
- G. Alarm Reporting:
 1. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.
 2. Operator shall be able to determine action to be taken in event of an alarm.
 3. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
 4. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.
- H. Remote Communication:
 1. System shall have ability to dial out in the event of an alarm.
- I. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

- J. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.
- K. Control Loops:
1. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
 - a. Two-position (on/off, open/close, slow/fast) control.
 - b. Proportional control.
 - c. Proportional plus integral (PI) control.
 - d. Proportional plus integral plus derivative (PID) control.
 - 1) Include PID algorithms with direct or reverse action and anti-windup.
 - 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
 - 3) Controlled variable, set point, and PID gains shall be operator-selectable.
 - e. Adaptive and intelligent self-learning control.
 - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
 - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
- L. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.
- M. Energy Calculations:
1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
 2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
 3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.
- N. Anti-Short Cycling:
1. DO points shall be protected from short-cycling.
 2. Feature shall allow minimum on-time and off-time to be selected.
- O. On and Off Control with Differential:
1. Include an algorithm that allows a DO to be cycled based on a controlled variable and set point.
 2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.
- P. Run-Time Totalization:

1. Include software to totalize run-times for all DI and DO points.
2. A high run-time alarm shall be assigned, if required, by operator.

2.15 ENCLOSURES

A. General Enclosure Requirements:

1. House each controller and associated control accessories in a single enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
3. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
4. Individual wall-mounted single-door enclosures shall not exceed 36 inches wide and 60 inches high.
5. Individual wall-mounted double-door enclosures shall not exceed 60 inches wide and 36 inches high.
6. Freestanding enclosures shall not exceed 48 inches wide and 72 inches high.
7. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
8. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door. For enclosures with windows, include pocket on bottom of enclosure.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Mount products within enclosure on removable internal panel(s).
11. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch- high lettering.
12. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
13. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
14. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
 2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
 3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
 4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
 5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
 6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.
- D. Wall Mounted NEMA 250, Types 4 and 12:
1. Enclosure shall be NRTL listed according to UL 508A.
 2. Seam and joints are continuously welded and ground smooth.
 3. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
 4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
 5. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
 6. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
 7. Construct enclosure of steel, not less than the following:
 - a. Size Less Than 24 Inches: 0.053 inch or 0.067 inch thick.
 - b. Size 24 Inches and Larger: 0.067 inch thick.
 8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior color shall be manufacturer standard.
 - b. Interior color shall be manufacturer standard.
 9. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
 - a. Sizes through 24 Inches Tall: Two hinges.
 - b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
 - c. Sizes Larger 48 Inches Tall: Four hinges.
 10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
 - a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.

11. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Size Less Than 24 Inches: Solid or perforated steel, 0.053 inch thick.
 - b. Size 24 Inches and Larger: Solid aluminum, 0.10 inch or steel, 0.093 inch thick.
12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
13. Grounding stud on enclosure body.
14. Thermoplastic pocket on inside of door for record Drawings and Product Data.

2.16 RELAYS

A. General-Purpose Relays:

1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Relays shall have LED indication and a manual reset and push-to-test button.
7. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 15 ms or less.
 - d. Dropout Time: 10 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.
 - g. Power Consumption: 2 VA.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Current Sensing Relay:

1. Monitors ac current.
2. Independent adjustable controls for pickup and dropout current.
3. Energized when supply voltage is present and current is above pickup setting.
4. De-energizes when monitored current is below dropout current.
5. Dropout current is adjustable from 50 to 95 percent of pickup current.
6. Include a current transformer, if required for application.
7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

C. Combination On-Off Status Sensor and On-Off Relay:

1. Description:

- a. On-off control and status indication in a single device.
 - b. LED status indication of activated relay and current trigger.
 - c. Closed-Open-Auto override switch located on the load side of the relay.
2. Performance:
 - a. Ambient Temperature: Minus 30 to 140 deg F.
 - b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.
 3. Status Indication:
 - a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
 - b. Current Sensor Range: Selected by application.
 - c. Current Set Point: Fixed or adjustable by application.
 - d. Current Sensor Output: Provide one of the following:
 - 1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
 - 2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
 - 3) Analog, zero- to 5- or 10-V dc.
 - 4) Analog, 4 to 20 mA, loop powered.
 4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
 5. Enclosure: NEMA 250, Type 2 enclosure.

2.17 ELECTRICAL POWER DEVICES

A. Transformers:

1. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80 percent of rated capacity.
 - a. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0 percent line and load combined, with 100-microsecond response time for 50 percent load changes. Unit shall have built-in overvoltage and overcurrent protection and shall be able to withstand a 150 percent current overload for at least three seconds without trip-out or failure.
 - 1) Unit shall operate between 0 deg C and 50 deg C (32 deg F and 120 deg F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration.
 - 2) Line voltage units shall be UL recognized and CSA approved.
2. Transformer shall be at least 40 VA.

B. Power-Line Conditioner:

1. General Power-Line Conditioner Requirements:

- a. Design to ensure maximum reliability, serviceability and performance.
 - b. Overall function of the power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. The power-line conditioner shall provide isolated, regulated, transient and noise-free sinusoidal power to loads served.
2. Standards: NRTL listed per UL 1012.
 3. Performance:
 - a. Single phase, continuous, 100 percent duty rated KVA/KW capacity. Design to supply power for linear or nonlinear, high crest factor, resistive and reactive loads.
 - b. Automatically regulate output voltage to within 2 percent or better with input voltage fluctuations of plus 10 to minus 20 percent of nominal when system is loaded 100 percent. Use Variable Range Regulation to obtain improved line voltage regulation when operating under less than full load conditions.
 - 1) At 75 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 35 percent of nominal.
 - 2) At 50 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 40 percent of nominal.
 - 3) At 25 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 45 percent of nominal.
 - c. With input voltage distortion of up to 40 percent, limit the output voltage sine wave to a maximum harmonic content of 5 percent.
 - d. Automatically regulate output voltage to within 2.5 percent when load (resistive) changes from zero percent to 100 percent to zero percent.
 - e. Output voltage returns to 95 percent of nominal level within two cycles and to 100 percent within three cycles when the output is taken from no load to full resistive load or vice-versa. Recovery from partial resistive load changes is corrected in a shorter period of time.
 - f. K Factor: 30, designed to operate with nonlinear, non-sinusoidal, high crest factor loads without overheating.
 - g. Input power factor within 0.95 approaching unity with load power factor as poor as 0.6.
 - h. Attenuate load-generated odd current harmonics 23 dB at the input.
 - i. Electrically isolate the primary from the secondary. Meet isolation criteria as defined in NFPA 70, Article 250-5D.
 - j. Lighting and Surge Protection: Compares to UL 1449 rating of 330 V when subjected to Category B3 (6000 V/3000 A) combination waveform as established by IEEE C62.41.
 - k. Common-mode noise attenuation of 140 dB.
 - l. Transverse-mode noise attenuation of 120 dB.
 - m. With loss of input power for up to 16.6 ms, the output sine wave remains at usable ac voltage levels.
 - n. Reliability of 200,000 hours' MTBF.
 - o. At full load, when measured at 1-m distance, audible noise is not to exceed 54 dB.
 - p. Approximately 92 percent efficient at full load.
 4. Transformer Construction:
 - a. Ferroresonant, dry type, convection cooled, 600V class. Transformer windings of Class H (220 deg C) insulated copper.
 - b. Use a Class H installation system throughout with operating temperatures not to exceed 150 deg C over a 40-deg C ambient temperature.

- c. Configure transformer primary for multi-input voltage. Include input terminals for source conductors and ground.
 - d. Manufacture transformer core using M-6 grade, grain-oriented, stress-relieved transformer steel.
 - e. Configure transformer secondary in a 240/120-V split with a 208-V tap or straight 120 V, depending on power output size.
 - f. Electrically isolate the transformer secondary windings from the primary windings. Bond neutral conductor to cabinet enclosure and output neutral terminal.
 - g. Include interface terminals for output power hot, neutral and ground conductors.
 - h. Label leads, wires and terminals to correspond with circuit wiring diagram.
 - i. Vacuum impregnate transformer with epoxy resin.
5. Cabinet Construction:
- a. Design for panel or floor mounting.
 - b. NEMA 250, Type 2, indoor enclosure.
 - c. Manufacture the cabinet from heavy gauge steel complying with UL 50.
 - d. Include a textured baked-on paint finish.
- C. Transient Voltage Suppression and High-Frequency Noise Filter Unit:
1. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz
 2. The maximum continuous operating voltage shall be at least 125 percent.
 3. The operating frequency range shall be 47 to 63 Hz.
 4. Protection modes according to NEMA LS-1.
 5. The rated single-pulse surge current capacity, for each mode of protection, shall be no less than the following:
 - a. Line to Neutral: 45,000 A.
 - b. Neutral to Ground: 45,000 A.
 - c. Line to Ground: 45,000 A.
 - d. Per Phase: 90,000 A.
 6. Clamping voltages shall be in compliance with test and evaluation procedures defined in NEMA LS-1. Maximum clamping voltage shall be as follows:
 - a. Line to Neutral: 360 V.
 - b. Line to Ground: 360 V.
 - c. Neutral to Ground: 360 V.
 7. Electromagnetic interference and RF interference noise rejection or attenuation values shall comply with test and evaluation procedures defined in NEMA LS-1.
 - a. Line to Neutral:

- 1) 100 kHz: 42 dB.
 - 2) 1 MHz: 25 dB.
 - 3) 10 MHz: 21 dB.
 - 4) 100 MHz: 36 dB.
- b. Line to Ground:
- 1) 100 kHz: 16 dB.
 - 2) 1 MHz: 55 dB.
 - 3) 10 MHz: 81 dB.
 - 4) 100 MHz: 80 dB.
8. Unit shall have LED status indicator that extinguishes to indicate a failure.
 9. Unit shall be listed by an NRTL as a transient voltage surge suppressor per UL 1449, and as an electromagnetic interference filter per UL 1283.
 10. Unit shall not generate any appreciable magnetic field.
 11. Unit shall not generate an audible noise.
- D. DC Power Supply:
1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
 2. Enclose circuitry in a housing.
 3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
 4. Performance:
 - a. Output voltage nominally 25-V dc within 5 percent.
 - b. Output current up to 100 mA.
 - c. Input voltage nominally 120-V ac, 60 Hz.
 - d. Load regulation within 0.5 percent from zero- to 100-mA load.
 - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
 - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

2.18 PIPING AND TUBING

- A. Tubing and Piping:
1. Products in this paragraph are intended for use with the following:
 - a. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers and accessories.
 2. Copper Tubing:
 - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties according to ASTM B 75.
 - b. Performance, dimensions, weight and tolerance according to ASTM B 280.
 - c. Diameter, by application, not less than nominal 0.25 inch.
 - d. Wall thickness, by the application, but not less than 0.030 inch.
 3. Copper Tubing Connectors and Fittings:

- a. Brass, compression type.
 - b. Brass, solder-joint type.
 4. Polyethylene Tubing:
 - a. Fire-resistant black virgin polyethylene according to ASTM D 1248, Type 1, Class C and Grade 5.
 - b. Tubing shall comply with stress crack test according to ASTM D 1693.
 - c. Diameter, by application, of not less than nominal 0.25 inch.
 5. Polyethylene Tubing Connectors and Fittings:
 - a. Brass, barbed fittings.
 - b. Brass, compression type.
- B. Process Tubing:
1. Products in this paragraph are intended for signals to instruments connected to liquid and steam systems.
 2. Copper Tubing:
 - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered with chemical and physical properties according to ASTM B 75.
 - b. Performance, dimensions, weight and tolerance according to ASTM B 280.
 - c. Diameter, by application, of not less than nominal 0.25 inch.
 - d. Wall thickness, by application, but not less than 0.030 inch.
 3. Copper Tubing Connectors and Fittings:
 - a. Brass, compression type.
 - b. Brass, solder-joint type.

2.19 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V.
1. Wire size shall be selected to meet manufacturer recommended voltage drop based on length of run and shall be at least No. 18 AWG.
 2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
 3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
 4. Conductor colors shall be black (hot), white (neutral), and green (ground).
 5. Furnish wire on spools.
- B. Single Twisted Shielded Instrumentation Cable above 24 V:
1. Wire size shall be selected to meet manufacturer recommended voltage drop based on length of run and shall be at least No. 18 AWG.
 2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
 3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
 4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.

6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
 7. Furnish wire on spools.
- C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
1. Wire size shall be selected to meet manufacturer recommended voltage drop based on length of run and shall be at least No. 18 AWG.
 2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
 3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
 4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
 7. Furnish wire on spools.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
1. Cable shall be balanced twisted pair.
 2. Comply with the following requirements and for balanced twisted pair cable described in Division 26 and 27.
 - a. Cable shall be plenum rated.
 - b. Cable shall have a unique color that is different from other cables used on Project.

2.20 RACEWAYS

- A. Comply with requirements in Division 26 and Division 27.

2.21 OPTICAL FIBER CABLE AND CONNECTORS

- A. Comply with requirements in Division 27.

2.22 AUXILIARY CONTROL DEVICES AND SENSORS

- A. Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:
1. Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.
 2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
 3. Rectangular control dampers shall be the parallel or opposed blade type as follows unless otherwise scheduled or shown on drawings.
 - a. Outdoor and/or return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade, arranged to direct airstreams toward each other.
 - b. Other modulating dampers shall be the opposed blade type.
 - c. Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals. Two-position dampers shall be full size of duct or equipment connection unless otherwise indicated.

4. Modulating dampers shall provide a linear flow characteristic.
5. Performance:
 - a. Leakage:
 - 1) Rectangular: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. (15.2 L/s per sq. m) against 1-in. wg (250-Pa) differential static pressure.
 - 2) Round: Leakage shall not exceed 0.15 cfm/in. (0.0028 L/s per mm) of perimeter blade at 4-in. wg (1000-Pa) differential static pressure.
 - b. Pressure Drop:
 - 1) Rectangular: 0.06-in. wg (12.5 Pa) at 1500 fpm (7.6 m/s) across a 24-by-24-inch (600-by-600-mm) damper when tested according to AMCA 500-D, figure 5.3.
 - 2) Round: 0.02-in. wg (5 Pa) at 1500 fpm (7.6 m/s) across a 12-inch (300-mm) damper when tested according to AMCA 500-D, figure 5.3.
 - c. Velocity:
 - 1) Rectangular: Up to 6000 fpm (30 m/s).
 - 2) Round: Up to 4000 fpm (20 m/s).
 - d. Temperature: Minus 20 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - e. Pressure Rating:
 - 1) Rectangular: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
 - 2) Round: 8-in. wg (2000 Pa) for sizes through 12 inches (300 mm), 6-in. wg (1500 Pa) for larger sizes.
 - f. Damper shall have AMCA seal for both air leakage and air performance.
6. Construction:
 - a. Frame:
 - 1) Rectangular select one of the following to match connecting ductwork:
 - a) ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, minimum 0.07 inch (1.8 mm) thick. Hat-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch (25 mm). Width not less than 5 inches (125 mm).
 - b) ASTM A653/A653M galvanized-steel profiles, minimum 0.06 inch thick. Hat-shaped channel with integral flanges. Mating face shall be a minimum of 1 inch (25 mm). Width not less than 5 inches (125 mm).
 - 2) Round to match connecting ductwork:
 - a) Material: Galvanized or stainless steel, 0.04 in (1.0 mm) thick. Outward rolled stiffener beads positioned approximately 1 inch (25 mm) inboard of each end. Sleeve-type connection for mating to adjacent ductwork. Size Range: 4 to 24 inches (100 to 600 mm). Length not less than 7 inches (175 mm).

mm). Provide 2-inch (50-mm) sheet metal stand-off for mounting actuator.

- b. Blades:
 - 1) Rectangular: Hollow, airfoil, extruded aluminum or galvanized-steel. Parallel or opposed blade configuration as required by application. Material: ASTM B211, Alloy 6063 T5 aluminum, 0.07 inch (1.8 mm) thick or ASTM A653/A653M galvanized steel, 0.05 inch thick. Width not to exceed 6 inches (150 mm). Length as required by close-off pressure, not to exceed 48 inches (1200 mm).
 - 2) Round: Double-thickness circular flat blades sandwiched together and constructed of galvanized or stainless steel.
 - c. Seals:
 - 1) Rectangular Damper Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite. Jambs: Stainless steel, compression type.
 - 2) Round Damper Blades: Polyethylene foam seal sandwiched between two sides of blades and fully encompassing blade edge.
 - d. All blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 10 cfm per square foot at 4 in. wg differential pressure. Provide air foil blades suitable for a wide-open face velocity of 1500 fpm.
 - e. Individual damper sections shall not be larger than 48 x 60 in. Provide a minimum of one damper actuator per section.
 - f. Axles: 0.5-inch- (13-mm-) diameter plated or stainless steel, mechanically attached to blades.
 - g. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze or better. Provide molded synthetic or stainless-steel sleeve mounted in frame. Where blade axles are installed in vertical position, provide thrust bearings.
 - h. Linkage: Dampers shall have exposed linkages. Constructed of aluminum and plated or stainless steel. Hardware: Stainless steel.
7. Flanges:
- a. Outward rolled with bolt holes on each end of frame for mating to adjacent ductwork.
 - b. Face: Not less than 1.25 inch (31 mm) for damper sizes through 12 inches (300 mm) in diameter, 1.5 inch (38 mm) for damper sizes 14 through 24 inches (350 through 600 mm) in diameter, and 2 inches (50 mm) for larger sizes.
8. Transition:
- a. For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
 - b. Factory mount damper in a sleeve with a close transition to mate to field connection.
 - c. Damper size and sleeve shall be connection size plus 2 inches (50 mm).
 - d. Sleeve length shall be not less than 12 inches (300 mm) for dampers without jackshafts and shall be not less than 16 inches (450 mm) for dampers with jackshafts.
 - e. Sleeve material shall match adjacent duct.

9. Airflow Measurement Dampers:
 - a. Where indicated, provide damper assembly with integral airflow monitoring.
 - b. Zero- to 10-V dc or 4- to 20-mA scaled output signal for remote monitoring of actual airflow.
 - c. Accuracy shall be within 5 percent of the actual flow rate between the range of minimum and design airflow. For applications with a large variation in range between the minimum and design airflow, configure the damper sections and flow measurement assembly as required to comply with the stated accuracy over the entire modulating range.
 - d. Provide a straightening device as part of the flow measurement assembly to achieve the specified accuracy with configuration indicated.
 - e. Suitable for operation in untreated and unfiltered air.
 - f. Provide temperature and altitude compensation and correction to maintain accuracy over temperature range encountered at site altitude.
 - g. Provide automatic zeroing feature.

10. Airflow Measurement and Control Dampers:
 - a. Where indicated, provide damper assembly with integral airflow measurement and control.
 - b. A factory-furnished and -calibrated controller shall be programmed, in nonvolatile EPROM, with application-specific airflow set point and range.
 - c. The controller and actuator shall communicate to control the desired airflow.
 - d. The controller shall receive a zero- to 10-V dc input signal and report a zero- to 20-mA output signal that is proportional to the airflow.
 - e. Airflow measurement and control range shall be suitable for operation between 150 to 2000 fpm (0.8 to 10 m/s).
 - f. Accuracy shall be within 5 percent of the actual flow rate between the range of minimum and design airflow.
 - g. Ambient Operating Temperature Range: Minus 40 to plus 140 deg F (Minus 40 to plus 60 deg C).
 - h. Ambient Operating Humidity Range: 5 to 95 percent relative humidity, non-condensing.
 - i. Provide unit with control transformer rated for not less than 85 VA. Provide transformer with primary and secondary protection and primary disconnecting means. Coordinate requirements with field power connection.
 - j. Provide screw terminals for interface to field wiring.
 - k. Factory mount electronics within a NEMA 250, Type 12 painted steel enclosure.

- B. Electric damper/valve actuators:
 1. The actuator shall have mechanical or electric stall protection to prevent damage to the actuator throughout the rotation of the actuator.
 2. Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided.
 3. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
 4. All 24 VAC DC actuators shall operate on Class 2 wiring.
 5. All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 N•m (60 in.·lb) torque capacity shall have a manual crank for this purpose.

6. Construction:
 - a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
 - b. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
 - c. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
7. Field Adjustment:
 - a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
 - b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
8. Two-Position Actuators: Single direction, spring return or reversing type.
9. Modulating Actuators:
 - a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
 - b. Control Input Signal:
 - 1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
 - 2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.
 - 3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
10. Programmable Multi-Function:
 - a. Control Input, Position Feedback, and Running Time: Factory or field programmable.
 - b. Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
 - c. Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
11. Position Feedback:
 - a. Where indicated, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open or close position as indicated.
 - b. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.
12. Fail-Safe:
 - a. Where indicated, provide actuator to fail to an end position.

- b. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
 - c. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.
13. Integral Overload Protection:
- a. Provide against overload throughout the entire operating range in both directions.
 - b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
14. Function properly within a range of 85 to 120 percent of nameplate voltage.
15. Sound:
- a. Spring Return: 62 dBA.
 - b. Non-Spring Return: 45 dBA.
16. Control valve actuators:
- a. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
 - b. Actuators for Steam Control Valves: Shutoff against 1.5 times steam design pressure.
 - c. Position indicator and graduated scale on each actuator.
 - d. Type: Motor operated, with or without gears, electric and electronic.
 - e. Voltage: 24-V ac or 120-V ac.
 - f. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
 - g. Valve Attachment:
 - 1) Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
 - 2) Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
 - 3) Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.
 - h. Valve Actuator Stroke Time Except Where Noted Otherwise:
 - 1) Operate valve from fully closed to fully opened within adjustable range of 75 to 100 seconds.
 - 2) Operate valve from fully opened to fully closed within adjustable range of 75 to 100 seconds.
 - 3) Move valve to failed position in less than within 20 seconds.
 - 4) Select operating speed to be compatible with equipment and system operation.
17. Damper Actuators:
- a. Type: Motor operated, with or without gears, electric and electronic.
 - b. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.

- c. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.
- d. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.
- e. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
- f. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
- g. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
- h. Provide mounting hardware and linkages for connecting actuator to damper.
- i. Select actuators to fail in desired position in the event of a power as indicated on the drawings.
- j. Damper Attachment:
 - 1) Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
 - 2) Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
 - 3) Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.
- k. Damper Stroke Time Limits Except Where Noted Otherwise:
 - 1) Operate damper from fully closed to fully open within adjustable range of 75 to 100 seconds.
 - 2) Operate damper from fully opened to fully closed within adjustable range of 75 to 100 seconds.
 - 3) Move damper to failed position in less than 25 seconds.
 - 4) Select operating speed to be compatible with equipment and system operation.
 - 5) Actuators operating in smoke control systems comply with governing code and NFPA requirements.

C. Digital Temperature Devices

- 1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 55 deg F to 85 deg F setpoint range, 2 deg F maximum differential, and vented ABS plastic cover.
- 2. Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 55 deg F to 85 deg F setpoint range, 2 deg F maximum differential, and vented ABS plastic cover.
- 3. Low-limit thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 20 foot minimum length. Element shall respond to the lowest temperature sensed by any 1 foot section. The low-limit thermostat shall be manual reset only.

D. Temperature Sensors

- 1. Temperature sensors shall be RTD or thermistor.

2. Duct sensors shall be single point or averaging type. Averaging sensors shall be a minimum of 5 feet in length per 10 square feet of duct cross section.
3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
4. Space sensors shall be equipped with setpoint adjustment, override switch, display, and/or communication port.
5. Provide matched temperature sensors for temperature differential measurement.
6. Platinum RTDs: Common Requirements:
 - a. 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
 - b. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
 - c. Performance Characteristics:
 - 1) Repeatability: Within 0.5 deg F.
 - 2) Self-Heating: Negligible.
 - d. Transmitter Requirements:
 - 1) Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
 - e. Duct Air Temperature Sensors:
 - 1) 1000 ohms.
 - 2) Single Probe Sensors:
 - a) Probe: Single-point sensor with a stainless-steel sheath.
 - b) Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
 - 3) Averaging Sensors:
 - a) Multiple sensors to provide average temperature across entire length of sensor.
 - b) Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
 - c) Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch (100-mm) radius.
 - d) Length: As required by application to cover entire cross section of air tunnel.
 - 4) Outdoor Air Sensors:
 - a) Probe: Single-point sensor with a stainless-steel sheath.
 - b) Solar Shield: Stainless steel.
 - 5) Enclosure: Junction box with removable cover; NEMA 250, Type 12 for indoor applications and Type 4 for outdoor applications.
 - 6) Gasket for attachment to duct or equipment to seal penetration airtight.
 - 7) Conduit Connection: 1/2-inch
 - f. Space Air Temperature Sensors:

- 1) Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic or flush, brushed-aluminum cover.
 - 2) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
 - 3) Concealed wiring connection.
7. Thermal Resistors (Thermistors): Common Requirements:
- a. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
 - b. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
 - c. Performance Characteristics:
 - 1) Repeatability: Within 0.5 deg F (0.3 deg C).
 - 2) Drift: Within 0.5 deg F (0.3 deg C) over 10 years.
 - 3) Self-Heating: Negligible.
 - d. Transmitter contingent on compliance with end-to-end control accuracy.
 - e. Duct Air Temperature Sensors:
 - 1) Single Probe Sensors
 - a) Probe: Single-point sensor with a stainless-steel sheath.
 - b) Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches (450 mm) long).
 - 2) Averaging Sensors
 - a) Multiple sensors to provide average temperature across entire length of sensor.
 - b) Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
 - c) Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch (100-mm) radius.
 - d) Length: As required by application to cover entire cross section of air tunnel.
 - 3) Outdoor Air Temperature Sensor
 - a) Probe: Single-point sensor with a stainless-steel sheath.
 - b) Solar Shield: Stainless steel.
 - 4) Enclosure: Junction box with removable cover; NEMA 250, Type 12 for indoor applications and Type 4 for outdoor applications.
 - 5) Gasket for attachment to duct or equipment to seal penetration airtight.
 - 6) Conduit Connection: 1/2- inch (16-mm) trade size.
 - f. Space Air Temperature Sensors
 - 1) Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic or flush, brushed-aluminum cover.
 - 2) Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
 - 3) Concealed wiring connection.

8. Air Temperature Switches

a. Thermostat and Switch for Low Temperature Control in Duct Applications:

1) Description:

- a) Two-position control.
- b) Field-adjustable set point.
- c) Manual reset.
- d) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2) Performance:

- a) Operating Temperature Range: 15 to 55 deg F (Minus 9 to 13 deg C).
- b) Temperature Differential: 5 deg F (2.8 deg C), non-adjustable and additive.
- c) Enclosure Ambient Temperature: Minus 20 to 140 deg F (Minus 11 to 60 deg C).
- d) Sensing Element Maximum Temperature: 250 deg F (121 deg C).
- e) Voltage: 120-V ac.
- f) Current: 16 FLA.
- g) Switch Type: Two SPDT snap switches operate on coldest 12-inch (300-mm) section along element length.

3) Construction:

- a) Vapor-Filled Sensing Element: Nominal 20 feet (6 m) long.
- b) Dual Temperature Scale: Fahrenheit and Celsius visible on face.
- c) Set-Point Adjustment: Screw.
- d) Enclosure: Painted metal, NEMA 250, Type 12.
- e) Electrical Connections: Screw terminals.
- f) Conduit Connection: 1/2-inch (16-mm) trade size.

b. Thermostat and Switch for High Temperature Control in Duct Applications:

1) Description:

- a) Two-position control.
- b) Field-adjustable set point.
- c) Manual reset.
- d) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2) Performance:

- a) Temperature Range: 100 to 160 deg F (38 to 71 deg C).
- b) Temperature Differential: 5 deg F (2.8 deg C).
- c) Ambient Temperature: Zero to 260 deg F (Minus 18 to 127 deg C).
- d) Voltage: 120-V ac.
- e) Current: 16 FLA.
- f) Switch Type: SPDT snap switch.

3) Construction:

- a) Sensing Element: Helical bimetal.
- b) Enclosure: Metal, NEMA 250, Type 12.
- c) Electrical Connections: Screw terminals.
- d) Conduit Connection: 1/2-inch (16-mm) trade size.

9. Air Temperature RTD Transmitters

a. Input:

- 1) 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.

b. Span (Adjustable):

- 1) Space: 40 to 90 deg F (4 to 32 deg C).
- 2) Supply Air Cooling and Heating: 40 to 120 deg F (4 to 49 deg C).
- 3) Supply Air Cooling Only: 40 to 90 deg F (4 to 32 deg C).
- 4) Supply Air Heating Only: 40 to 120 deg F (4 to 49 deg C).
- 5) Exhaust Air: 50 to 100 deg F (10 to 38 deg C).
- 6) Return Air: 50 to 100 deg F (10 to 38 deg C).
- 7) Mixed Air: Minus 40 to 140 deg F (Minus 40 to 60 deg C).
- 8) Outdoor: Minus 40 to 140 deg F (Minus 40 to 60 deg C).

c. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.

d. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F (28 deg C).

e. Match sensor with temperature transmitter and factory calibrate together.

f. Performance Characteristics:

- 1) Calibration Accuracy: Within 0.1 percent of the span.
- 2) Stability: Within 0.2 percent of the span for at least 6 months.
- 3) Combined Accuracy: Within 0.5 percent.

10. Liquid and Steam Temperature Sensors

a. Assembly: Sensor manufacturer shall furnish sensor, thermowell, and sensor connection head to provide a matched assembly.

b. RTD

- 1) Resistance temperature sensors shall comply with IEC 60751, Class B requirements.
- 2) Platinum with a value of 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
- 3) Encase RTD in a Type 316 stainless-steel sheath with a 0.25-inch (8-mm) OD.
- 4) Provide PTFE-insulated, nickel-coated, 22-gage, stranded copper leads.
- 5) Provide spring-loaded RTDs for thermowell installations.
- 6) Performance Characteristics:

a) Interchangeable Accuracy: Within 0.54 deg F (0.3 deg C) at 32 deg F (zero deg C).

b) Stability: Within 0.05 percent maximum ice-point resistance shift after 1000 hours at 752 deg F (400 deg C).

- c) Hysteresis: Within 0.04 percent of range.
- d) Response Time: 62.8 percent of change in 4 seconds with water flowing across sensor at 3 fps (0.9 m/s).

c. Thermowells

- 1) Stem: Straight or stepped or tapered shank formed from solid bar stock.
- 2) Material: Type 304 or Type 316 stainless steel.
- 3) Process Connection: Threaded, NPS 3/4 (DN 20)
- 4) Sensor Connection: Threaded, NPS 1/2 (DN 15)
- 5) Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
- 6) Furnish thermowells installed in insulated pipes and equipment with an extended neck that extends beyond the face of the insulation covering.
- 7) Length: As required by application and pipe size.
- 8) Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

d. Connection Heads:

- 1) Housing: Low-copper cast-aluminum alloy, complying with NEMA 250, Type 4.
- 2) Terminals: Six or eight as required by sensor.
- 3) Conduit Connection: 1/2-inch (16-mm) trade size.
- 4) Sensor Connection: NPS 1/2 (DN 15).

11. Liquid Temperature Switches for Temperature Control in Pipe Applications

a. Description:

- 1) Two-position control.
- 2) Field-adjustable set point.
- 3) Manual reset.
- 4) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

b. Performance:

- 1) Temperature Differential Deadband: 5 to 30 deg F (3 to 17 deg C), adjustable.
- 2) Enclosure Ambient Temperature: 150 deg F (66 deg C).
- 3) Sensing Element Pressure Rating: 200 psig (1379 kPa).
- 4) Voltage: 120-V ac.
- 5) Current: 8 FLA.
- 6) Switch Type: SPDT snap switch.

c. Construction:

- 1) Vapor-Filled Immersion Element: Copper, nominal 3 inches (75 mm) long.
- 2) Temperature Scale: Fahrenheit, visible on face.
- 3) Set-Point Adjustment: Screw.
- 4) Enclosure: Painted metal, NEMA 250, Type 12.
- 5) Electrical Connections: Screw terminals.
- 6) Conduit Connection: 3/4-inch (21-mm) trade size).

12. Liquid and Steam Temperature Transmitters

- a. House electronics in NEMA 250, Type 4 or Type 4X enclosure.
- b. Enclosure Connection: 1/2-inch (16-mm) trade size.
- c. Functional Characteristics:
 - 1) Input: 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, sensors.
 - 2) Default Span (Adjustable):
 - a) Chilled Water: Zero to 100 deg F (Minus 18 to 38 deg C).
 - b) Condenser Water: Zero to 120 deg F (Minus 18 to 49 deg C).
 - c) Heating Hot Water: 32 to 212 deg F (Zero to 100 deg C).
 - d) Heat Recovery: Zero to 120 deg F (Minus 18 to 49 deg C).
 - 3) Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
 - 4) Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F (28 deg C).
 - 5) Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.
- d. Performance Characteristics:
 - 1) Stability: Within 0.2 percent of the span for at least 6 months.
 - 2) Combined Accuracy: Within 0.5 percent.

E. Humidity Sensors

1. Duct and room sensors shall have a sensing range of 20 percent to 80 percent.
2. Duct sensors shall be provided with a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 20 percent to 95 percent rh. They shall be suitable for ambient conditions of 40 deg F to 170 deg F.
4. Humidity sensor drift shall not exceed 1 percent of full scale per year.
5. Sensors and Transmitters with Digital Display:
 - a. Performance:
 - 1) Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 2.5 percent from 90 to 100 percent relative humidity when operating between 60 to 77 deg F (16 to 25 deg C).
 - 2) Relative Humidity Range: Zero to 100 percent.
 - 3) Factory calibrated and NIST traceable with certificate included.
 - b. Construction:
 - 1) Provide housing with integral sensor for room applications.
 - 2) Provide housing with remote sensor probe for ducted applications.
 - a) Duct Sensor Body: 300 series stainless steel or chrome-plated aluminum, at least 2 inches long for duct-mounted applications.

- b) Provide sensor with cable for field installation in conduit.
 - c) For duct-mounted applications, thread the sensor assembly for connection to a threaded mounting flange.
- 3) Provide general-purpose humidity sensor unless application requires special requirements. Provide sensor with sintered stainless-steel filter for duct applications.
 - 4) Housing shall be ABS/PC plastic or powder-coated aluminum.
 - 5) Housing Classification: NEMA 250, Type 4 or 4X.
 - 6) Provide housing with wall-mounting plate.
- c. Output Signal: 2-wire, 4- to 20-mA output signal with a drive capacity of at least 500 ohms at 24-V dc.
 - d. Provide unit with a digital display of relative humidity in percent.
6. Sensor and Transmitter without Display:
- a. Performance:
 - 1) Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 3 percent from 90 to 95 percent relative humidity when operating at 68 deg F (20 deg C).
 - 2) Hysteresis: Within 1 percent.
 - 3) Relative Humidity Range:
 - a) Duct: Zero to 100 percent.
 - b) Space: Zero to 95 percent relative.
 - 4) Factory calibrated and NIST traceable with certificate included.
 - b. Construction for Space Applications:
 - 1) Housing with integral sensor.
 - 2) Housing shall be ABS plastic or powder-coated aluminum.
 - 3) Enclosure: NEMA 250, Type 4.
 - 4) Provide housing with a wall-mounting plate.
 - c. Construction for Duct and Equipment Applications:
 - 1) Housing with integral sensor.
 - 2) Duct Sensor Body: 300 series stainless steel, 6 inches (150 mm) long for duct-mounted applications.
 - 3) For outdoor and duct applications, install circuitry in a NEMA 250, Type 4 or 4X enclosure
 - 4) Provide sensor with sintered stainless-steel filter for duct applications.
 - 5) Housing shall be cast aluminum.
 - 6) Enclosure: NEMA 250, Type 4.
 - d. Output Signal:
 - 1) Two-wire, 4- to 20-mA output signal with drive capacity of at least 500 ohms at 24-V dc.
 - 2) Non-interacting zero and span adjustments.

7. Combination Humidity and Temperature Sensor and Transmitter (Dewpoint Sensor):
 - a. Description:
 - 1) Factory package consisting of humidity and temperature sensor, installation hardware, interconnecting sensor cabling, installation instructions, and operating manual.
 - 2) Each transmitter shall be individually calibrated and provided with NIST traceable calibration certifications.
 - 3) Provide a service cable for connecting to a notebook computer and Microsoft Windows compatible software.
 - b. Display for Non-Duct Mounted Applications Only:
 - 1) Alphanumeric display of the following on the face of the enclosure:
 - a) Percent relative humidity.
 - b) Absolute humidity.
 - c) Mixing ratio.
 - d) Dry-bulb temperature.
 - e) Wet-bulb temperature.
 - f) Dew point temperature.
 - g) Enthalpy.
 - 2) Visual display of measurement trends, and minimum and maximum values over a one-year period.
 - c. Electronics Enclosure:
 - 1) Integral to sensors for wall-mounted applications and remote from temperature and humidity sensors for duct and equipment applications.
 - 2) NEMA 250, Type 4 or 4X.
 - 3) Labeled terminal strip for field wiring connections.
 - 4) 0.63-inch trade size threaded conduit connection.
 - d. Programming:
 - 1) Transmitter parameters shall be field programmable through keypad on the face of the enclosure.
 - 2) Programmed parameters shall be stored in nonvolatile EEPROM.
 - e. Output Signals:
 - 1) Three Analog Outputs: 4 to 20 mA or zero to 10-V dc for each output. Option to use a serial communication interface.
 - 2) Provide analog dewpoint reading output compatible with associated DDC system controller.
 - f. Temperature Sensor:
 - 1) Temperature range matched to application, but not less than minus 40 to 140 deg F (minus 40 to 60 deg C).

- 2) Within 0.5 deg F (0.3 deg C) accuracy over the temperature range of 50 to 100 deg F (10 to 38 deg C) and within 1 deg F (0.6 deg C) over the remainder of the range.
- 3) Provide duct installation kit for duct applications.

g. Humidity Sensor:

- 1) Relative Humidity Measurement Range: Zero to 100 percent.
- 2) Response time in still air within 40 seconds.
- 3) Accuracy including non-linearity, hysteresis, and repeatability:
 - a) For Temperature Between 59 and 77 Deg F (15 to 25 Deg C) and Relative Humidity between Zero and 90 Percent: Within 1 percent.
 - b) For Temperature between 59 and 77 Deg F (15 to 25 Deg C) and Relative Humidity between 90 and 100 Percent: Within 1.7 percent.
 - c) For Temperature between Minus 4 and 104 Deg F (Minus 20 to 40 Deg C): Within 1 percent plus 0.008 times relative humidity reading.
 - d) For Temperature between Minus 40 and 356 Deg F (Minus 40 to 180 Deg C): Within 1.5 percent plus 0.015 times the relative humidity reading.
- 4) Sintered, stainless-steel filter, protecting sensor.
- 5) Provide duct installation kit for duct applications.

h. Power Supply:

- 1) Field Power: 120-V ac, 60 Hz unless otherwise required by the application.
- 2) Internal Power: As required by transmitter.

F. Current Transmitters

1. AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and ± 1 percent full-scale accuracy at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UUCSA Recognized.
3. Unit shall be split-core type for clamp-on installation on existing wiring.

G. Current Transformers

1. AC current transformers shall be UUCSA Recognized and completely encased (except for terminals) in approved plastic material.
2. Transformers shall be available in various current ratios and shall be selected for ± 1 percent accuracy at 5 A full-scale output.
3. Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.

H. Voltage Sensing

1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
2. Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with ± 1 percent full-scale accuracy with 500 ohm maximum burden.

3. Transmitters shall be UUCSA Recognized at 600 VAC rating and meet or exceed ANSI/ ISA S50.1 requirements.
- I. Voltage Transformers
 1. AC voltage transformers shall be UUCSA Recognized, 600 VAC rated, complete with built-in fuse protection.
 2. Transformers shall be suitable for ambient temperatures of 4 degC to 55 deg C (40 deg F to 130 deg F) and shall provide ± 0.5 percent accuracy at 24 VAC and a 5 VA load.
 3. Windings (except for terminals) shall be completely enclosed with metal or plastic.
 - J. Power Monitors
 1. Selectable rate pulse output for kWh reading, 4-20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0-0.33 volt inputs.
 2. 1.0 percent full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120-600 V, and auto range select.
 3. Under voltage/phase monitor circuitry.
 4. NEMA 1 enclosure.
 5. Current transformers having a 0.5 percent FS accuracy, 600 VAC isolation voltage with 0-0.33V output. If 0-5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.
 - K. Pressure Instruments
 1. Air Pressure Sensors
 - a. Duct Insertion Static Pressure Sensor:
 - 1) Sensor probe with two opposing orifices designed to reduce error-associated air velocity.
 - 2) Sensor insertion length shall be as recommended by the manufacturer for the duct size served.
 - 3) Construct sensor of 6061-T6 aluminum alloy or Type 304 stainless steel.
 - 4) Connection: Threaded, NPS 1/8 (DN 6) swivel fitting for connection to copper tubing or NPS 1/4 (DN 10) barbed fitting for connection to polyethylene tubing.
 - 5) Sensor probe attached to a mounting flange with neoprene gasket and two holes for fasteners.
 - 6) Mounting flange shall suitable for flat oval, rectangular, and round duct configurations.
 - 7) Pressure Rating: 10 psig (69 kPa).
 - b. Duct Traverse Static Pressure Sensor:
 - 1) Sensor shall traverse the duct cross section and have at least one pickup point every 6 inches (150mm) along length of sensor.
 - 2) Construct sensor of 18-gage Type T6063-T5 extruded and anodized aluminum.
 - 3) Sensor supported with threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at other end.
 - 4) Mounting plate with threaded, NPS 3/8 (DN 12) compression fitting for connection to tubing.
 - 5) Accuracy within 1 percent of actual operating static pressure.

- 6) Dual offset static sensor design shall provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30 degree yaw and pitch.
- 7) Suitable for velocities of 100 to 10000 fpm (0.51 to 51 m/s) and temperatures of up to 200 deg F (93 deg C).
- 8) Sensor air resistance shall be less than 0.1 times the velocity pressure at probe-operating velocity.
- 9) Suitable for flat oval, rectangular, and round duct configurations.

c. Outdoor Static Pressure Sensor:

- 1) Manufacturers: Acceptable manufacturers, subject to compliance with the requirements of the specification:
 - a) Air Monitor Corporation - Static Outside Air Probe
 - b) Vaisala - Static Pressure Head
- 2) Provides average outdoor pressure signal.
- 3) Sensor with no moving parts.
- 4) Pressure Connection: Brass barbed fitting for NPS 1/4 (DN 10) tubing.
- 5) Conduit fitting around pressure fitting for sensor support and protection to pressure connection.
- 6) Include sensor, tubing and mounting hardware.
- 7) Operation not affected and impaired by rain and snow.
- 8) Sensing plates constructed of type 316 stainless steel or aluminum.
- 9) Accuracy within:
 - a) 1 percent of the actual outdoor atmospheric pressure when subjected to varying horizontal radial wind velocities up to 40 mph.
 - b) 2 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 30 degrees to horizontal.
 - c) 3 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 60 degrees to horizontal.

d. Space Static Pressure Sensor for Wall Mounting

- 1) Aluminum or Stainless-steel wall plate with sensing port, perforated center or multiple sensing ports arranged to sense space static pressure. Include pressure impulse suppression chamber and airflow shielding. Exposed metal surfaces are provided with brush finish.
- 2) Back of sensor plate fitted with brass barbed or brass union fitting for tubing connection.
- 3) Wall plate provided with matching color screws and sized to fit standard single-gang electrical box.
- 4) Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm (5.1 m/s) from a 360-degree radial source.
- 5) Pressure rating: 10 psig (69kPa).

2. Air Pressure Switches

- a. Air-Pressure Differential Switch
 - 1) UL listed, diaphragm-operated SPDT snap-acting, with scale range and differential suitable for intended application.
 - a) Fan safety shutdown applications: Switch with manual reset.
 - 2) Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
 - 3) Enclosure Conduit Connection: Knock out or threaded connection.
 - 4) User Interface: Screw-type set-point adjustment with enclosed set-point indicator and scale.
 - 5) High and Low Process Connections: Threaded, NPS 1/8 (DN 6).
 - 6) Enclosure:
 - a) Dry Indoor Installations: NEMA 250, Type 12.
 - b) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
 - c) Hazardous Environments: Explosion proof.
 - 7) Operating Data:
 - a) Electrical Rating: 15 A at 120- to 480-V ac.
 - b) Pressure Limit Continuous: 45 inches wg (11.2 kPa).
 - c) Pressure Limit Surge: 10 psig (68.9 kPa).
 - d) Temperature Limits: Minus 30 to 180 deg F (Minus 34 to 82 deg C).
 - e) Operating Range: Approximately 2 times set point.
 - f) Repeatability: Within 3 percent.
 - g) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- b. Air-Pressure Differential Indicating Switch
 - 1) Combination gage with low- and high-limit switches.
 - 2) Nominal 4-inch- (100-mm-) diameter analog indication with white dial face, graduated black markings, pointer to indicate measured value, and a separate adjustable pointer for each switch set point.
 - 3) Switch zero and set-point tamperproof adjustment screws or knobs on the dial face.
 - 4) Each switch used as a safety limit shall have a manual reset button local to switch.
 - 5) Switch Type: Each set point shall have two Form C relays, DPDT.
 - 6) Electrical Connections: Screw terminals.
 - 7) Enclosure Conduit Connection: NPS 3/4 (DN 20) threaded connection.
 - 8) High and Low Process Connections: Threaded, NPS 1/8 (DN 6).
 - 9) Enclosure:
 - a) Dry Indoor Installations: NEMA 250, Type 12.
 - b) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
 - c) Hazardous Environments: Explosion proof.
 - 10) Operating Data:

- a) Electrical Rating: 10 A at 120- to 240-V ac.
- b) Pressure Limits: 25 psig (172 kPa).
- c) Temperature Limits: 20 to 120 deg F (Minus 7 to 49 deg C).
- d) Operating Range: Approximately twice normal operating range unless otherwise required for application.
- e) Accuracy: 4 percent for ranges through 0.5 in. wg (125 Pa), 2 percent for ranges 1 in. wg (250 Pa) and greater.
- f) Repeatability: Within 1 percent of full scale.
- g) Switch Deadband: One pointer width and within 1 percent of full scale for each switch set point.
- h) Power Supply: 24 or 120-V ac, 50/60 Hz.
- i) Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Air Pressure Differential Transmitters

- a. Transmitter with automatic zeroing circuit capable of automatically readjusting the transmitter to zero at predetermined time intervals. The automatic zeroing circuit shall re-zero the transmitter to within 0.1 percent of true zero.
- b. Integral digital display for continuous indication of pressure differential
- c. Performance:
 - 1) Range: Approximately 2 times set point or as required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
 - 2) Calibrated Span: Field adjustable, minus 40 percent of the range.
 - 3) Accuracy: Within 0.10 percent of natural span.
 - 4) Repeatability: Within 0.15 percent of calibrated span.
 - 5) Linearity: Within 0.2 percent of calibrated span.
 - 6) Hysteresis and deadband (combined): Less than 0.2 percent of calibrated span.
 - 7) Stability: Within 0.25 percent of span per year.
 - 8) Overpressure: 1 psig (69 kPa).
 - 9) Temperature Limits: Zero to 150 deg F (Minus 18 to 66 deg C).
 - 10) Compensate Temperature Limits: 40 to 135 deg F (4 to 57 deg C).
 - 11) Thermal Effects: 0.033 percent of full scale per degree F.
 - 12) Warm-up Time: Within 5 seconds.
 - 13) Response Time: 5 ms.
 - 14) Shock and vibration shall not harm the transmitter.
- d. Output Signals:
 - 1) Analog Current Signal: 4- to 20-mA dc current source. Signal capable of operating into 800-ohm load.
- e. Display: Four-digit digital display with minimum 0.4-inch- (10-mm-) high numeric characters.
- f. Operator Interface: Zero and span adjustments within 10 percent of full span. Potentiometer adjustments located on face of transmitter.
- g. Construction:
 - 1) Type 300 stainless-steel enclosure.

- 2) Threaded, NPS 1/4 (DN 10) swivel fittings for connection to copper tubing or NPS 3/16 (DN 7) barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
- 3) Screw terminal block for wire connections.
- 4) Vertical plane mounting.
- 5) NEMA 250, Type 4.
- 6) Provide mounting bracket suitable for installation.
- 7) Reverse wiring protected.
- 8) Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.

L. Leak Detection Instruments

1. Point-Type, Leak-Detection Switches

- a. Features: Audible and visual alarm with relay output for remote indication.
- b. Alarm activated based on change in resistance.
- c. Performance:
 - 1) Service: Water.
 - 2) Temperature Limits: 32 to 122 deg F (zero to 50 deg C).
 - 3) Switch Type: SPDT relay.
 - 4) Electric Connection: Cable attached.
- d. Construction: Acrylic, ABS plastic.
- e. Field Power: 24-V ac or dc.

M. Motion Sensors

1. Indoor Motion Sensors

- a. Description: Wall- or ceiling-mounted, solid-state units with a separate relay unit.
 - 1) Operation: Unless otherwise indicated, turn on when covered area is occupied and off when unoccupied; with a time delay for turning off, adjustable over a minimum range of 1 to 15 minutes.
 - 2) Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 3) Relay Unit: Dry contacts rated for 20-A load at 120- and 277-V ac. Power supply to sensor shall be 24-V dc, 150 mA, Class 2 power source as defined by NFPA 70.
 - 4) Mounting:
 - a) Sensor: Suitable for mounting in any position on a standard outlet box.
 - b) Relay: Externally mounted through a 1/2-inch (13-mm) knock out in a standard electrical enclosure.
 - c) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 5) Indicator: Digital display, to show when motion is being detected during testing and normal operation of the sensor.
 - 6) Bypass Switch: Override the on function in case of sensor failure.

- b. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in coverage area. A particular technology or combination of technologies that controls on-off functions shall be field selectable by operating controls on unit.
 - 1) Sensitivity Adjustment: Separate for each sensing technology.
 - 2) Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 - 3) Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling. Apply occupancy detectors where indicated.

N. Current Switches

- 1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

O. Local Control Panels General Requirements

- 1. A single key shall be common to all field panels and subpanels.
- 2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- 3. Provide on/off power switch with overcurrent protection for control power sources to each local panel.

2.23 WIRING AND RACEWAYS

- A. General. Provide copper wiring, plenum cable, and raceways as specified in Division 26.
- B. All insulated wire to be copper conductors, UL labeled for 194 deg F minimum service.

2.24 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate the following according to industry standards for each product, and to verify DDC system reliability specified in performance requirements:
 - 1. DDC controllers.
 - 2. Gateways.
 - 3. Routers.
 - 4. Operator workstations.
- B. Product(s) and material(s) will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

2.25 IDENTIFICATION

A. Instrument Air Pipe and Tubing:

1. Engraved tag shall bear the following information:
 - a. Service (Example): "Instrument Air."
 - b. Pressure Range (Example): 0 to 30 psig.
2. Letter size shall be a minimum of 0.25 inch high.
3. Tag shall consist of white lettering on blue background.
4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded blue with contrasting white center exposed by engraving through outer layer.
5. Include tag with a brass grommet, chain and S-hook.

B. Control Equipment, Instruments, and Control Devices:

1. Laminated acrylic or melamine plastic sign bearing unique identification.
 - a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Letter size shall be as follows:
 - a. Operator Workstations: Minimum of 0.5 inch high.
 - b. Printers: Minimum of 0.5 inch high.
 - c. DDC Controllers: Minimum of 0.5 inch high.
 - d. Gateways: Minimum of 0.5 inch high.
 - e. Repeaters: Minimum of 0.5 inch high.
 - f. Enclosures: Minimum of 0.5 inch high.
 - g. Electrical Power Devices: Minimum of 0.25 inch high.
 - h. UPS units: Minimum of 0.5 inch high.
 - i. Accessories: Minimum of 0.25 inch high.
 - j. Instruments: Minimum of 0.25 inch high.
 - k. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
3. Legend shall consist of white lettering on black background.
4. Laminated acrylic or melamine plastic sign shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer and shall be fastened with drive pins.
5. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

C. Raceway and Boxes:

1. Comply with requirements for identification specified in Division 26.
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.
3. For raceways housing air signal tubing, add a phenolic tag labeled "HVAC Air Signal Tubing."

D. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch beyond white border.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Thoroughly examine plans for control device and equipment locations. Discrepancies, conflicts, or omissions shall be reported to the architect for resolution before rough-in work is started.
- B. Inspect the site to verify that equipment may be installed as shown. Discrepancies, conflicts, or omissions shall be reported to the architect for resolution before rough-in work is started.
- C. Examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the work of this Section and the plans and the work of others, report these discrepancies to the architect and obtain written instructions for any changes necessary to accommodate the work of this Section with the work of others. Changes in the work of this Section made necessary by the failure or neglect to report such discrepancies shall be made by, and at the expense of this Section.
- D. Examine roughing-in for products to verify actual locations of connections before installation.
 1. Examine roughing-in for instruments installed in piping and duct systems to verify actual locations of connections before installation.
- E. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- F. Prepare written report with input from installers listing conditions detrimental to performance of the Work.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PROTECTION

- A. Protect all work and material from damage. This Section shall be liable for damage caused by work or employees of this Section.
- B. This Section shall be responsible for work and equipment until finally inspected, tested, and accepted. Protect material that is not immediately installed. Close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

- A. Where the work will be installed in close proximity to, or will interfere with, work of other trades, assist in working out space conditions to make adjustments. If work is installed before coordinating with other trades causing interference with work of other trades, make changes to work to correct the condition without extra charge.

- B. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- C. Test and Balance
 - 1. Furnish a single set of all tools necessary to interface to the BAS for test and balance purposes.
 - 2. Provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
 - 3. In addition, provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 - 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- D. Life Safety
 - 1. Duct smoke detectors required for air handler shutdown are supplied under Division 28 of this specification. This Section shall interlock smoke detectors to equipment (e.g. air handlers) for shutdown.
 - 2. Smoke dampers and actuators required for duct smoke isolation are provided under a Section of Division 23. This Section shall interlock these dampers to associated equipment for shutdown.
 - 3. Fire/smoke dampers and actuators are provided under another Section of Division 23. Control of these dampers shall be by Division 28.
- E. Coordination with Controls Specified in Other Sections or Divisions; Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the BAS specified in this section. These controls shall be integrated into the system. Coordinate as follows:
 - 1. Provide communication media and equipment.
 - 2. Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
 - 3. Coordinate and resolve incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
 - 4. Provide controls described in the contract documents regardless of where within the contract documents these controls are described.
 - 5. Interface control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 INSTRUMENT APPLICATIONS

A. Temperature Instruments:

1. Provide device identified in "Input Point Displayed Accuracy and Control Accuracy" table.

B. Humidity Sensors

1. Sensor and transmitter with digital display or a combination humidity and temperature sensor and transmitter with display.

C. Airflow Measurement Stations:

1. For Air-Ducted/Plenum:

- a. Measured Velocities Greater Than 200 fpm (1.0 m/s): Thermal airflow measurement station.)
- b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.

2. Duct-Mounted Airflow Sensors:

- a. Thermal airflow station.
- b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.

3. Damper-Mounted Airflow Sensors:

- a. Measured Velocities 400 fpm (2.0 m/s) and Less: Thermal airflow station.
- b. Measured Velocities Greater than 500 fpm (2.5 m/s): Damper with integral flow measurement or damper with integral flow control.
- c. Provide a remotely mounted microprocessor-based transmitter at each measurement location.

4. Fan Airflow Sensors:

a. Fan-Mounted

- 1) Measured Velocities 500 fpm (2.5 m/s) and Less: Thermal airflow station.
- 2) Measured Velocities Greater than 500 fpm (2.5 m/s): Piezometer ring fan inlet airflow sensor.

- b. Provide a remotely mounted microprocessor-based transmitter at each measurement location.

D. Airflow Switches:

1. Measured Velocities 400 fpm (2.0 m/s) and Less: Polymer film sail switch.
2. Measured Velocities Greater than 400 fpm (2.0 m/s): Stainless steel single-vane switch.

3.6 WIRING

- A. Control and interlock wiring shall comply with national and local electrical codes and Division 26 of this specification. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.
- B. NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC and Division 26 requirements.
- C. Low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.)
- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL Listed for the intended application. For example cables used in ceiling plenums shall be UL Listed specifically for that purpose.
- E. Wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage— shall be installed in raceway at levels below 10 ft.
- F. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- G. Do not install wiring in raceway containing tubing.
- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 10 ft intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire Connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 1 in. or larger.

- Q. Use coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 in. from high-temperature equipment (e.g., steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- U. Adhere to Division 26 requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
- W. Terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- X. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Flexible metal raceway less than 1/2 in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

- A. Adhere to "Wiring" paragraphs of this Section.
- B. Cabling shall be installed in a neat and work-manlike manner. Follow manufacturer installation recommendations for all communication cabling.
- C. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Verify the integrity of the entire network following the cable installation. Use test measures specific to each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer instructions.
- G. All runs of communication wiring shall be un-spliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.

- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each 1 square foot of coil area.
- G. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- H. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location
- I. Differential Air Static Pressure
 1. Duct Pressure Sensors
 - a. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - b. Return Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - c. Install sensors using manufacturer's recommended upstream and downstream distances.
 - d. Unless indicated on Drawings, locate sensors approximately 67 percent of distance of longest hydraulic run. Location of sensors shall be submitted and approved before installation.
 - e. Install mounting hardware and gaskets to make sensor installation airtight.
 - f. Route tubing from the sensor to transmitter.
 - g. Use compression fittings at terminations.
 - h. Install sensor in accordance with manufacturer's instructions.
 - i. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

2. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a shielded outside air probe and a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - a. Manufacturer: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Air Monitor Corporation (S.O.A.P).
 - 2) Vaisala - Static Pressure Head
 - b. Provide an outdoor static pressure sensor constructed of 10 ga. Type 316 stainless steel with a 2" diameter FPT connection. The outdoor air probe shall be capable of sensing the outside atmospheric air pressure to within 2 percent of the actual value when subjected to radial wind velocities up to 40 miles per hour with approach angles up to 30° to the horizontal.
 - c. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
 - d. Locate wall-mounted sensor in an inconspicuous location.
 - e. Submit sensor location for approval before installation.
 - f. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.
 - g. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.
 - h. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
 - i. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
 - j. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.
 3. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 4. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 5. All air and water differential pressure sensors shall have gage tees mounted adjacent to the taps. Water gages shall also have shutoff valves installed before the tee.
- J. Air-Pressure Differential Switches
1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
 2. A single sensor may be used to share a common signal to multiple pressure instruments.
 3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
 4. Route NPS 3/8 (DN 12) tubing from sensor to switch connection.
 5. Do not mount switches on rotating equipment.
 6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
 7. Install switches in an easily accessible location serviceable from floor.
 8. Install switches adjacent to system control panel if within 50 feet; otherwise, locate switch in vicinity of system connection.

3.9 ACTUATOR INSTALLATION

- A. Mount and link control damper actuators according to manufacturer instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic
 - 1. Dampers. Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degrees available for tightening the damper seals. Actuators shall be mounted following manufacturer recommendations.

3.10 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the BAS.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows:

CAUTION
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to off position before servicing.

- B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows:

CAUTION
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.11 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2 in. of termination with the BAS address or termination number.
- B. All pneumatic tubing shall be labeled at each end within 2 in. of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.

- D. Identify control panels with minimum 1/2 in. letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- F. Identify room sensors relating to terminal box or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

3.12 CONTROLLER INSTALLATION

- A. In addition to zone control requirements identified, provide a separate programmable application controller for each of the following to minimize impact of a controller failure on system operation:
 - 1. Air handling unit.
 - 2. Exhaust fan.
 - 3. Chiller and directly associated pumps and towers.
 - 4. Boiler and directly associated pumps and towers.
 - 5. Each pump not directly associated with main equipment shall be on separate controllers.
- B. A BAS controller may control more than one system provided that all points associated with the system are assigned to the same BAS controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

3.13 SOFTWARE PROGRAMMING

- A. Provide internal memory capacity for the specified sequences of operation and trend logging. Provide a minimum of 25 percent of available memory free for future use.
- B. Point Naming. Request in writing project owner standard point naming convention. Where owner written response indicates no standard is available, system point names shall be modular in design, allowing easy operator interface without the use of a written point index and use the following naming convention:
 - 1. AA.BBB.CCDDE where:
 - a. AA is used to designate the location of the point within the building, such as mechanical room, wing, or level, or the building itself in a multi-building environment;
 - b. BBB is used to designate the mechanical system with which the point is associated (e.g., A01, HTG, CLG, LTG);
 - c. CC represents the equipment or material referenced (e.g., SF for supply fan, RW for return water, EA for exhaust air, ZN for zone).
 - d. D or DD may be used for clarification or for identification if more than one CC exists (e.g., SF10, ZNB);
 - e. E represents the action or state of the equipment or medium (e.g., T for temperature, H for humidity, C for control, S for status, D for damper control, I for current).
- C. Software Programming

1. Provide programming for the system and adhere to the sequences of operation. Provide other system programming required for the operation of the system, but not specified in this document. Imbed into the control program comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based
 - 1) Must provide actions for all possible situations
 - 2) Must be modular and structured
 - 3) Must be commented
 - b. Graphic-based
 - 1) Must provide actions for all possible situations
 - 2) Must be documented
 - c. Parameter-based
 - 1) Must provide actions for all possible situations
 - 2) Must be documented
- D. Operator Interface
1. Standard graphics: Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all points for the system. Show relevant calculated points such as setpoints.
 2. Show terminal equipment information on a graphic summary table. Provide dynamic information for each point shown.
 3. Provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.14 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Communication Interface to Equipment with Integral Controls:
1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
 2. Equipment to Be Connected:
 - a. Energy recovery ventilators specified in Division 23.
 - b. Split Systems specified in Division 23.
- B. Communication Interface to Other Building Systems:
1. DDC system shall have a communication interface with systems having a communication interface.
 2. Systems to Be Connected:

- a. Fire-alarm system specified in Division 28.

3.15 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in this Section, to installers for field installation.
- B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
 1. DDC control dampers.
 2. Airflow sensors and switches.
 3. Duct pressure sensors.

3.16 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Division 07.
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Division 07.
- H. Welding Requirements:
 1. Restrict welding and burning to supports and bracing.
 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.

- J. Install products in locations that are accessible and that will permit calibration, service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

3.17 ROUTER INSTALLATION

- A. Install routers if required for DDC system communication interface.
- B. Test router to verify that communication interface functions properly.

3.18 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply and to UPS units.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
 - 1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. Install controllers in a protected location that is easily accessible by operators.
 - 3. Top of controller shall be within 72 inches of finished floor.
- F. Installation of Programmable Application Controllers:
 - 1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. Install controllers in a protected location that is easily accessible by operators.
 - 3. Top of controller shall be within 72 inches of finished floor.
- G. Application-Specific Controllers:
 - 1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.19 ENCLOSURES INSTALLATION

- A. Install the following items in enclosures, to comply with indicated requirements:
 - 1. Gateways.
 - 2. Routers.
 - 3. Controllers.
 - 4. Electrical power devices.
 - 5. UPS units.
 - 6. Relays.

7. Accessories.
 8. Instruments.
 9. Actuators
- B. Attach wall-mounted enclosures to wall using the following types of steel struts:
1. For NEMA 250, Type 2 and Type 12 Enclosures: Use painted steel, galvanized-steel or corrosion-resistant-coated steel strut and hardware.
 2. For NEMA 250, Type 4 Enclosures Located Outdoors: Use stainless-steel strut and hardware.
 3. Install plastic caps on exposed cut edges of strut.
- C. Align top or bottom of adjacent enclosures of like size.
- D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized- or stainless-steel anchors.

3.20 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

- A. Mounting Location:
1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
 2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
 3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
 6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
 7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.
 8. Install transmitters for gas associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
 9. Install gas switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
- B. Mounting Height:
1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.

2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
 - a. Make every effort to mount at 60 inches.
- C. Special Mounting Requirements
 1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
 2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.
- D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- E. Space Temperature Sensor Installation
 1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
 2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
 3. In finished areas, recess electrical box within wall.
 4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
 5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.
- F. Outdoor Temperature Sensor Installation
 1. Mount sensor in a discrete location facing north.
 2. Protect installed sensor from solar radiation and other influences that could impact performance.
 3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.
- G. Single-Point Duct Temperature Sensor Installation
 1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches (610 mm) in sensor length.
 2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
 3. Rigidly support sensor to duct and seal penetration airtight.
 4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.
- H. Averaging Duct Temperature Sensor Installation

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. (1.86 sq. m) and larger.
 2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
 3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
 4. If required to have transmitter, mount transmitter in an accessible and serviceable location.
- I. Low-Limit Air Temperature Switch Installation
1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
 2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
 3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
 4. Install on entering side of cooling coil unless otherwise indicated on Drawings.
- J. Liquid Temperature Sensor Installation
1. Assembly shall include sensor, thermowell and connection head.
 2. For pipe NPS 4 (DN 100) and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
 3. For pipe smaller than NPS 4 (DN 100):
 - a. Install reducers to increase pipe size to NPS 4 (DN 100) at point of thermowell installation.
 - b. For pipe sizes NPS 2-1/2 and NPS 3 (DN 65 and DN 80), thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
 - c. Minimum insertion depth shall be 2-1/2 inches (65 mm).
 4. Install matching thermowell.
 5. Fill thermowell with heat-transfer fluid before inserting sensor.
 6. Tip of spring-loaded sensors shall contact inside of thermowell.
 7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
 8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
 9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor, service platform or catwalk.

3.21 FLOW INSTRUMENTS INSTALLATION

- A. Airflow Sensors:
1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.

2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.
- B. Transmitters:
1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
 2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.22 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections. All power wiring and connections required to operate the DDC system and all control components shall be provided by this Section. Provide normal and standby power wiring to all devices to perform sequences outlined. As a minimum the DDC system (all control panels, workstations or host computers) shall be connected to standby power source. Power circuits for all DDC system component shall be dedicated only to the DDC system and components. All wiring from and including dedicated circuit breakers to the point of use shall be provided by this Section.
- B. Work shall comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Division 26 for electrical power circuit breakers.
- D. Comply with requirements in Division 26 for electrical power conductors and cables.
- E. Comply with requirements in Division 26 for electrical power raceways and boxes.

3.23 IDENTIFICATION

- A. Install laminated acrylic or melamine plastic signs with unique identification on face for each of the following:
1. Operator workstation.
 2. Printer.
 3. Gateway.
 4. Router.
 5. Protocol analyzer.
 6. DDC controller.
 7. Enclosure.
 8. Electrical power device.
 9. UPS unit.
 10. Accessory.
- B. Install unique instrument identification on face of each instrument connected to a DDC controller.
- C. Install engraved phenolic nameplate with valve identification on control damper and valve and on face of ceiling directly below valves concealed above ceilings connected to a DDC controller.

- D. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.
- E. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.
- F. Warning Labels and Signs:
 - 1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
 - 2. Shall be located in highly visible location near power service entry points.
- G. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Division 26.

3.24 NETWORK INSTALLATION

- A. Install optical fiber cable when connecting between the following network devices and when located in different buildings on campus and when required to meet communication speeds specified:
 - 1. Operator workstations.
 - 2. Operator workstations and network controllers.
 - 3. Network controllers.
- B. Install balanced twisted pair or optical fiber cable when connecting between the following network devices located in same building while meeting communication speeds specified:
 - 1. Operator workstations.
 - 2. Operator workstations and network controllers.
 - 3. Network controllers.
- C. Install balanced twisted pair or copper cable when connecting between the following:
 - 1. Gateways.
 - 2. Gateways and network controllers or programmable application controllers.
 - 3. Routers.
 - 4. Routers and network controllers or programmable application controllers.
 - 5. Network controllers and programmable application controllers.
 - 6. Programmable application controllers.
 - 7. Programmable application controllers and application-specific controllers.
 - 8. Application-specific controllers.
- D. Install cable in continuous raceway.
 - 1. Cable trays may be used for copper cable in lieu of conduit.

3.25 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.
- B. ASHRAE 135 Networks:

1. MAC Address:
 - a. Every network device shall have an assigned and documented MAC address unique to its network.
 - b. Ethernet Networks: Document MAC address assigned at its creation.
 - c. ARCNET or MS/TP networks: Assign from 00 to 64.
2. Network Numbering:
 - a. Assign unique numbers to each new network.
 - b. Provide ability for changing network number through device switches or operator interface.
 - c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
3. Device Object Identifier Property Number:
 - a. Assign unique device object identifier property numbers or device instances for each device network.
 - b. Provide for future modification of device instance number by device switches or operator interface.
 - c. LAN shall support up to 4,194,302 unique devices.
4. Device Object Name Property Text:
 - a. Device object name property field shall support 32 minimum printable characters.
 - b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
 - 1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
 - 2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".
5. Object Name Property Text for Other Than Device Objects:
 - a. Object name property field shall support 32 minimum printable characters.
 - b. Assign object name properties with plain-English names descriptive of application.
 - 1) Example 1: "Zone 1 Temperature."
 - 2) Example 2 "Fan Start and Stop."
6. Object Identifier Property Number for Other Than Device Objects:
 - a. Object identifier property numbers may be assigned at Installer discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

3.26 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Division 26 and 27.
 2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
 3. Terminate wiring in a junction box.
 - a. Clamp cable over jacket in junction box.
 - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
 4. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
 5. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
 6. Use shielded cable to transmitters.
 7. Use shielded cable to temperature sensors.
 8. Perform continuity and meager testing on wire and cable after installation.
- C. Conduit Installation:
1. Comply with Division 26 for control-voltage conductors.
 2. Comply with Division 27 for balanced twisted pair cabling and optical fiber installation.

3.27 OPTICAL FIBER CABLE SYSTEM INSTALLATION

- A. Comply with installation requirements in Division 27.

3.28 CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4 in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 1/8 in. of each other.
- D. Follow the manufacturer instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to manufacturer instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)

- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.
- J. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
- K. Clearance:
 - 1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
 - 2. Install dampers with at least 24 inches (600 mm) of clear space on sides of dampers requiring service access.
- L. Service Access:
 - 1. Dampers and actuators shall be accessible for visual inspection and service.
 - 2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23.
- M. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
- N. Attach actuator(s) to damper drive shaft.
- O. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.29 DUCT SMOKE DETECTION

- A. Coordinate duct smoke detector installation with Division 27. Connect to dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.30 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1, "General," of this specification.
- B. Continually monitor the field installation for code compliance and quality of workmanship.
- C. Have work inspected by local and/or state authorities having jurisdiction over the work.
- D. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- E. Manufacturer Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.
- F. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Testing:
 - 1. Perform pre-installation, in-progress, and final tests, supplemented by additional tests.
 - 2. Pre-installation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
 - 3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
 - 4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
 - 5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
 - 6. Test Results: Record test results and submit copy of test results for Project record.

3.31 DDC SYSTEM CHECKOUT - GENERAL

- A. Start-up Testing. Testing listed in this article shall be performed and shall make up part of the necessary verification of an operating BAS. This testing shall be completed before the owner representative is notified of the system demonstration.
 - 1. Furnish labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 - 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 3. Enable the BAS and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer recommendations.
 - 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
 - 5. Verify that all analog output devices (modulating actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. Check all control valves and automatic dampers to ensure proper action and closure. Make adjustments to valve stem and damper blade travel.

6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start/stop routines.
7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
- B. Start up, check out, and test all hardware and software and verify communication between all components.
 1. Verify control wiring is properly connected and free of all shorts and ground faults. Verify terminations are tight.
 2. Verify analog and binary input/ output points read properly.
 3. Verify alarms and interlocks. Verify operation of the integrated system.

3.32 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.
- E. Control Damper Checkout:
 1. Check installed products before continuity tests, leak tests, and calibration.
 2. Check dampers for proper location and accessibility.
 3. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
 4. Verify that control dampers are installed correctly for flow direction.
 5. Verify that proper blade alignment, either parallel or opposed, has been provided.
 6. Verify that damper frame attachment is properly secured and sealed.
 7. Verify that damper actuator and linkage attachment are secure.
 8. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 9. Verify that damper blade travel is unobstructed.
- F. Instrument Checkout:
 1. Check out installed products before continuity tests, leak tests, and calibration.
 2. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
 3. Check instruments for proper location and accessibility.
 4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
 5. Verify that attachment is properly secured and sealed.

6. Verify that conduit connections are properly secured and sealed.
7. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
8. Inspect instrument tag against approved submittal.
9. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
10. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
11. For temperature instruments:
 - a. Verify sensing element type and proper material.
 - b. Verify length and insertion.

3.33 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
 1. Check digital signals using a jumper wire.
 2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:

1. Stroke and adjust control dampers following manufacturer recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
3. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Control Valves:

1. Stroke and adjust control valves following manufacturer recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
3. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.34 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.35 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.

4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:
 - a. Upper quarter of range.
 - b. Lower quarter of range.
 - c. At midpoint of range.
8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

3.36 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
 1. Detailed explanation for any items that are not completed or verified.
 2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
 3. HVAC equipment motors operate below full-load amperage ratings.
 4. Required DDC system components, wiring, and accessories are installed.
 5. Installed DDC system architecture matches approved Drawings.
 6. Control electric power circuits operate at proper voltage and are free from faults.
 7. Required surge protection is installed.
 8. DDC system network communications function properly, including uploading and downloading programming changes.
 9. Each controller programming is backed up.
 10. Equipment, products, tubing, wiring cable and conduits are properly labeled.
 11. All I/O points are programmed into controllers.
 12. Testing, adjusting and balancing work affecting controls is complete.
 13. Dampers and actuators zero and span adjustments are set properly.
 14. Each control damper and actuator goes to failed position on loss of power.
 15. Valves and actuators zero and span adjustments are set properly.
 16. Each control valve and actuator goes to failed position on loss of power.
 17. Meter, sensor and transmitter readings are accurate and calibrated.
 18. Control loops are tuned for smooth and stable operation.
 19. View trend data where applicable.
 20. Each controller works properly in standalone mode.

21. Safety controls and devices function properly.
22. Interfaces with fire-alarm system function properly.
23. Electrical interlocks function properly.
24. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
25. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
 - a. Verify analog I/O points at operating value.
 - b. Make adjustments to out-of-tolerance I/O points.
 - 1) Identify I/O points for future reference.
 - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
 - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:
 - a. Re-check I/O points that required corrections during initial test.
 - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
 - a. Re-check I/O points that required corrections during second test.
 - b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.
 - a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
 2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
 3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
 4. Purpose of test is to demonstrate DDC system, as follows:
 - a. Reaction to COV and alarm conditions during HLC.
 - b. Ability to update DDC system database during HLC.
 5. Passing test is contingent on the following:
 - a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
 - b. All alarms, both binary and analog, are reported and printed; none are lost.
 - c. Compliance with response times specified.
 6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.
- H. DDC System Network Bandwidth Test:
1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
 2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.37 FINAL REVIEW

- A. Submit written request to Architect and Construction Manager when DDC system is ready for final review. Written request shall state the following:
 1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
 2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
 3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
 4. DDC system is complete and ready for final review.
- B. Review by Architect and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and

subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.

- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. A part of DDC system final review shall include a demonstration to parties participating in final review.
 - 1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
 - 2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
 - 3. Demonstration shall include, but not be limited to, the following:
 - a. Accuracy and calibration of (10) I/O points randomly selected by the Architect. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
 - b. HVAC equipment and system hard wired and software safeties and life-safety functions are operating according to sequence of operation. Up to (20) I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
 - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
 - d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
 - e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
 - f. Trends, summaries, logs and reports set-up for Project.
 - g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
 - h. Software ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
 - i. Software ability to edit control programs off-line.
 - j. Data entry to show Project-specific customizing capability including parameter changes.
 - k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
 - l. Execution of digital and analog commands in graphic mode.
 - m. Spreadsheet and curve plot software and its integration with database.
 - n. Online user guide and help functions.
 - o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
 - p. System speed of response compared to requirements indicated.
 - q. For Each Network and Programmable Application Controller:
 - 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.

- 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer technical literature.
 - 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
 - 4) Electric Power: Ability to disconnect any controller safely from its power source.
 - 5) Wiring Labels: Match control drawings.
 - 6) Network Communication: Ability to locate a controller location on network and communication architecture matches Shop Drawings.
 - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
- r. For Each Operator Workstation:
- 1) I/O points lists agree with naming conventions.
 - 2) Graphics are complete.
 - 3) UPS unit, if applicable, operates.
- s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Requirements must be met even if only one manufacturer equipment is installed.
- 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
 - 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
 - 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.
 - 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
 - 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with approved privileges are permitted.
 - 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
 - 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with approved privilege.
 - 8) Archival Storage of Data: Data archiving is handled by operator workstation and local trend archiving and display is accomplished.
 - 9) Modification of Trend Log Object Parameters: Operator with approved privilege can change logged data points, sampling rate, and trend duration.
 - 10) Device and Network Management:

- a) Display of network device status.
- b) Display of BACnet Object Information.
- c) Silencing devices transmitting erroneous data.
- d) Time synchronization.
- e) Remote device re-initialization.
- f) Backup and restore network device programming and master database(s).
- g) Configuration management of routers.

3.38 ADJUSTING

- A. Occupancy Adjustments: When requested within (12) months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.39 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by DDC system manufacturer authorized service representative. Include monthly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting for proper operation. Parts and supplies shall be manufacturer authorized replacement parts and supplies.

3.40 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.41 ACCEPTANCE

- A. All tests described in this specification shall have been performed to the satisfaction of both the architect and owner prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the owner. Such tests shall then be performed as part of the warranty.
- B. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

END OF SECTION 23 09 23

SECTION 23 31 13 – AIR DISTRIBUTION SYSTEMS – METAL DUCTS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Backdraft and pressure relief dampers.
8. Barometric relief dampers.
9. Manual volume dampers.
10. Control dampers.
11. Fire dampers.
12. Smoke dampers.
13. Combination fire and smoke dampers.
14. Corridor dampers.
15. Flange connectors.
16. Insulated louver blank off panels
17. Duct silencers.
18. Turning vanes.
19. Duct-mounted access doors.
20. Duct access panel assemblies.
21. Flexible connectors.
22. Duct accessory hardware.
23. Insulated flexible ducts.
24. Diffuser, registers & grilles

B. Related Requirements:

1. Division 23 "Vibration, Wind and Seismic Controls for HVAC" for seismic and wind restraint devices and installation.
2. Division 23 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Division 23 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
4. Division 23 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

4. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings. Dynamic insertion loss shall be calculated based upon submitted coordination drawing system locations.
 5. Flexible Ducts
- B. Sustainable Design Submittals:
1. Ventilation: Product Data for ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 2. Product Data: For adhesives and sealants, indicating VOC content.
 3. Product data showing compliance with ASHRAE 62.1.
 4. Laboratory Test Reports: For adhesives, insulation, antimicrobial coatings, and sealants, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 2. Factory- and shop-fabricated ducts and fittings.
 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 4. Elevation of top and bottom of ducts.
 5. Dimensions of main duct runs from building grid lines.
 6. Fittings.
 7. Reinforcement and spacing.
 8. Seam and joint construction.
 9. Penetrations through fire-rated and other partitions.
 10. Equipment installation based on equipment being used on Project.
 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
 13. 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. Include diagrams for power, signal, and control wiring.
- D. Delegated Design Submittals:
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.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Plans shall show ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved. Refer to Division 20 for requirements.
- B. Welding certificates.
- C. Field quality-control reports.
- D. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with 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 D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

1.7 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.
- B.** Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"
- C. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

- E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation, duct lining, or duct wall thickness.
- G. Comply with NFPA 90A and NFPA 90B.
- H. 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.
- I. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- J. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

1.8 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
- D. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- 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.

1.9 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.

2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
 3. Welded sections of ductwork shall be minimum 16 gage sheet metal, provide SMACNA thickness where pressure class requires heavier gage.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
 2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
 3. Where specified for specific applications, all joints are to be welded.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.
1. Where specified for specific applications, all joints are to be welded.
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. The following elbows in Table 4-2 shall not be used:
 - a. Type RE-2, Square throat with vanes (acceptable for low pressure only where H & W is less than 18, otherwise default to Type RE-3)
 - b. Type RE-4, Square throat without vanes
 - c. Type RE-7, 45degree throat, 45degree heel
 2. The following divided flow branch fittings in Table 4-5 shall not be used:
 - a. Type 2
 3. The following branch connections in Table 4-6 shall not be used:
 - a. Straight tap
 - b. Cinch lock
 - c. Flanged or spin-in connections without conical or bell mouth transition
 4. The following obstruction methods in Table 4-8 shall not be used:
 - a. Figure D, use Figure B instead.

1.10 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 2. For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Linx Industries; a DMI company \(formerly Lindab\).](#)
 - b. [McGill AirFlow LLC.](#)
 - c. [Nordfab Ducting.](#)
 - d. [SEMCO, LLC; part of FlaktGroup.](#)
 - e. [Sheet Metal Connectors, Inc.](#)
- B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.
- C. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. The following fittings in Table 3-5 shall not be used:
 - a. 90 degree tee fitting
 - b. 90 degree tap
 - c. 90 degree saddle fitting
 - d. Rectangular straight tap

1.11 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Certainteed; SAINT-GOBAIN.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)
 - c. [Knauf Insulation.](#)
 - d. [Owens Corning.](#)
 - e. [Sekisui Voltek, LLC.](#)
2. Source Limitations: Obtain fibrous-glass duct liner from single manufacturer.
3. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
4. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
5. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.
 - a. [Verify adhesive has a VOC](#) content of 80 g/L or less. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Aeroflex USA.](#)
 - b. [Armacell LLC.](#)
 - c. [K-Flex USA.](#)
 - d. [Sekisui Voltek, LLC.](#)
2. Source Limitations: Obtain flexible elastomeric duct liner from single manufacturer.
3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. [Verify adhesive has a VOC](#) content of 80 g/L or less. Fibrous-Glass-Free, Natural-Fiber Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Acoustical Surfaces, Inc.](#)
 - b. [Ductmate Industries, Inc; a DMI company.](#)
2. Source Limitations: Obtain fibrous-glass-free, natural-fiber duct liner from single manufacturer.

3. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
 5. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. Verify adhesive has a VOC content of 80 g/L or less. Polyolefin Duct Liner: Cross-linked, partially open-cell polyolefin foam sheet or roll materials, with reinforced aluminum foil facing and adhesive backing, complying with NFPA 90A or NFPA 90B; sheet (Type II) complying with ASTM C1427.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Sekisui Voltek, LLC.
 2. Source Limitations: Obtain polyolefin duct liner from single manufacturer.
 3. Foam Core Density: 1.5 pcf.
 4. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
 5. Minimum Noise Reduction Coefficient (NRC): 0.50 for 3/8-inch thickness, 0.45 for 5/8-inch thickness, 0.55 for 1-inch thickness, 0.55 for 2-1/8-inch thickness.
 6. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 7. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. Verify adhesive has a VOC content of 80 g/L or less. Insulation Pins and Washers:
 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.
- F. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. 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.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. 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.

1.12 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 4 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. [Verify sealant has a VOC](#) content of 420 g/L or less. Water-Based Joint and Seam Sealant (Duct Air Temperatures above 0 degrees F):
 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. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
 8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant (Duct Air Temperatures below 0 degrees F, cold climate outside air ducts):
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. Verify sealant has a VOC content of 420 g/L or less. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 10. Service: Indoor or outdoor.
 11. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. Verify sealant has a VOC content of 420 g/L or less. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and is to 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.
- 1.13 HANGERS AND SUPPORTS
- A. Hanger Rods for Noncorrosive Environments: Galvanized-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. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

- F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

1.14 MANUAL VOLUME DAMPERS

- A. Low Pressure (2" pressure class and under), Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. [Air Balance; MESTEK, Inc.](#)
 - b. [Aire Technologies, Inc.; DMI Companies.](#)
 - c. [American Warming and Ventilating \(AWV\); Mestek, Inc.](#)
 - d. [Greenheck Fan Corporation.](#)
 - e. [McGill AirFlow LLC.](#)
 - f. [Nailor Industries Inc.](#)
 - g. [Pottorff.](#)
 - h. [Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.](#)
 - i. [Vent Products Co., Inc.](#)
 - 2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 20 cfm/sq. ft. against 1-inch wg differential static pressure.
 - 3. General Requirements:
 - a. Minimum Air Velocity Rating: 2000 fpm.
 - b. Maximum System Pressure: 2 inches wg.
 - 4. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 - 5. Frames:
 - a. Hat-shaped, material shall match ductwork construction.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 6. Blades:
 - a. Multiple or single blade.

- b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Material shall match connected ductwork.
 7. Blade Axles: Material shall match connected ductwork.
 8. Bearings:
 - a. Molded synthetic when installed in galvanized ductwork, Oil-impregnated stainless steel sleeve when installed in stainless steel ductwork.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 9. Tie Bars and Brackets: Material shall match ductwork construction.
 10. Locking device to hold damper blades in a fixed position without vibration.
- B. Medium Pressure (2" and above pressure class) Manual Volume Dampers:
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Greenheck Fan Corporation.](#)
 - b. [McGill AirFlow LLC.](#)
 - c. [Nailor Industries Inc.](#)
 - d. [Pottorff.](#)
 - e. [Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.](#)
 2. Performance:
 - a. AMCA Certification: Test and rate in accordance with AMCA 511.
 - b. Leakage: Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
 3. Construction: Linkage: Out of airstream. Suitable for horizontal or vertical airflow applications.
 4. Frames: Hat, U, or angle shaped. Material shall match connected ductwork. Mitered and welded corners. Flanges for attaching to walls and flangeless frames for installing in ducts.
 5. Blades: Multiple or single blade. Parallel- or opposed-blade design. Stiffen damper blades for stability. Roll-formed material shall match connected ductwork.
 6. Blade Edging Seals: PVC.
 7. Blade Jamb Seals: Vinyl.
 8. Blade Axles: Material shall match connected ductwork.
 9. Bearings:
 - a. Molded synthetic for galvanized ductwork, or Oil-impregnated stainless steel sleeve for stainless steel ductwork.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 10. Tie Bars and Brackets: Material shall match connected ductwork.
 11. Locking device to hold damper blades in a fixed position without vibration.
- C. Jackshaft:
 1. Size: 0.5-inch diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. 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.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

1.15 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Greenheck Fan Corporation](#).
2. [McGill AirFlow LLC](#).
3. [NCA Manufacturing, Inc.; Metal Industries, Inc.](#)
4. [Nailor Industries Inc.](#)
5. [Pottorff](#).
6. [Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.](#)
7. [Young Regulator Company](#).

B. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

C. Performance:

1. AMCA Certification: Test and rate in accordance with AMCA 511.
2. Leakage:
 - a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4. Velocity: Up to 3000 fpm.
5. Temperature: Minus 25 to plus 180 deg F.
6. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:

1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:

- a. Hat, U, or angle shaped.
 - b. Extruded aluminum.
 - c. Interlocking, gusseted corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
- a. Multiple blade with maximum blade width of 6 inches.
 - b. Opposed-blade design.
 - c. Aluminum.
 - d. 16-gauge-thick single skin or 14-gauge-thick air foil dual skin.
5. Blade Edging Seals: Replaceable Closed-cell neoprene.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch diameter; galvanized steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings: Molded synthetic. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.
- E. Damper Actuator - Electric:
1. Electric - 24 V ac.
 2. UL 873, plenum rated.
 3. Two position with fail-safe spring return.
 - a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
 - b. Minimum 90-degree drive rotation.
 4. Clockwise or counterclockwise drive rotation as required for application.
 5. Environmental Operating Range:
 - a. Temperature: Minus 40 to plus 130 deg F.
 - b. Humidity: 5 to 95 percent relative humidity noncondensing.
 6. Environmental enclosure: NEMA 2.
 7. Actuator to be factory mounted and provided with a single-point wiring connection.
- F. Controllers, Electrical Devices, and Wiring:
1. Comply with requirements for electrical devices and connections specified in Division 23 "Direct Digital Control (DDC) System for HVAC."
 2. Electrical Connection: 24 V, 60 Hz.
- 1.16 INSULATED LOUVER BLANK OFF PANELS
- A. Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.
1. Thickness: 2 inches.
 2. Metal Facing Sheets, Aluminum: Not less than 0.032-inch nominal thickness.
 3. Insulating Core: Rigid, glass-fiber-board insulation or extruded-polystyrene foam.

4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard channel frames, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
6. Panel Finish: Same finish applied to louvers, color to be selected by Architect.
7. Attach blank-off panels with clips.

1.17 TURNING VANES

A. Radius Elbows

1. Elbows and offsets shall be constructed with full radius elbows, where the inside elbow radius is equal to the width of the duct in plane of the elbow. Where full radius elbows are installed, turning vanes are not required.
2. Where elbows have less than full radius, provide quantity of full radius turning vanes indicated below per SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Chart 4-1, "Number of Short Radius Vanes." R is equal to inside elbow radius. W is equal to width of the duct in plane of the elbow.
 - a. $1 > R/W \geq 0.5$: One splitter vane
 - b. $0.5 > R/W \geq 0.25$: Two splitter vanes
 - c. $0.25 > R/W > 0.05$: Three splitter vanes

B. Mitered Elbows (Only to be used when shown on plan)

1. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

1.18 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Ductmate Industries, Inc; a DMI company.
2. Duro Dyne Inc.
3. McGill AirFlow LLC.
4. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. 24-gauge-thick galvanized steel or 0.032-inch-thick aluminum or 24-gauge thick stainless steel door panel.
 - d. Vision panel.
 - e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - f. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - a. 24-gauge-thick galvanized steel or 0.032-inch-thick aluminum frame.
3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 InchesSquare: No hinges and two sash locks.
 - b. Access Doors up to 18 InchesSquare: Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

1.19 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [CL WARD & Family Inc.](#)
 2. [Ductmate Industries, Inc; a DMI company.](#)
 3. [Duro Dyne Inc.](#)
 4. [DynAir; a Carlisle Company.](#)
 5. [Elgen Manufacturing.](#)
 6. [Ventfabrics, Inc.](#)
 7. [Ward Industries; a brand of Hart & Cooley, LLC.](#)
- B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Materials: Flame-retardant or noncombustible fabrics.
- E. Coatings and Adhesives: Comply with UL 181, Class 1.
- F. 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. Provide metal compatible with connected ducts.
- G. 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.
- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. 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 rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

1.20 DUCT ACCESSORY HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. [CL WARD & Family Inc.](#)
 2. [Ductmate Industries, Inc; a DMI company.](#)
 3. [Duro Dyne Inc.](#)
 4. [DynAir; a Carlisle Company.](#)
 5. [Elgen Manufacturing.](#)
 6. [Ward Industries; a brand of Hart & Cooley, LLC.](#)
- B. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

1.21 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. [Buckley Associates](#)
 2. [Flexmaster U.S.A., Inc.](#)
 3. [JP Lamborn Co.](#)
 4. [McGill AirFlow LLC.](#)
 5. [Thermaflex; a Flex-Tek Group company.](#)
 6. [Ward Industries; a brand of Hart & Cooley, LLC.](#)
- B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 175 deg F.
 4. Insulation R-Value: Comply with ASHRAE/IES 90.1.
- C. 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.

1.22 DIFFUSERS, REGISTERS & GRILLES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
- a. [Carnes Company.](#)
 - b. [Hart & Cooley, LLC.](#)
 - c. [Krueger-HVAC; brand of Johnson Controls International plc, Global Products.](#)
 - d. [METALAIRE, Inc.](#)
 - e. [Nailor Industries Inc.](#)
 - f. [Price Industries Limited.](#)
 - g. [Titus; brand of Johnson Controls International plc, Global Products.](#)
 - h. [Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.](#)
- B. Provide diffusers, registers, and grilles for supply, return and exhaust outlets of size, type and material of construction matching the basis of design devices scheduled on the drawings.
- C. Equipment shall be tested and rated according to ASHRAE Standard 70-2006 (RA 2011), "Method of Testing for Rating the Performance of Air Outlets and Inlets".
- D. Room air velocities shall be determined in accordance with ASHRAE Standard 113-2013.
- E. Coordinate diffusers, registers and grilles with ceiling and wall construction. Refer to Architectural Drawings for exact lengths and for framing and mitering arrangements that may differ from those shown on Division 23 Drawings.
- F. General Construction and Performance Requirements
1. Supply diffusers shall be specifically designed for variable-air-volume flows.
 2. Material: Steel, aluminum or stainless steel consistent with basis of design scheduled diffuser, register or grille.
 3. Finish: Steel and aluminum diffusers, registers and grilles shall have a baked enamel finish with color selected by Architect. Stainless steel diffusers and grilles shall have a brushed finish.
 4. Mounting: Coordinate selections with ceiling grid indicated on the architectural drawings.
 5. Pattern: Provide fully adjustable or fixed pattern consistent with scheduled basis of design diffuser, register or grille.
 6. Dampers: Opposed blade or butterfly as indicated.
 7. Accessories:
 - a. Equalizing grid where run out branch to the device is less than 18 inches long.
 - b. Aluminum plaster ring for devices mounted in dry wall, masonry, or tile construction.
 - c. Safety chain for devices with a face area equal to or larger than 3 square feet.
- G. RECTANGULAR AND SQUARE CEILING DIFFUSERS
1. Devices shall be specifically designed for variable-air-volume flows.
 2. Material: Steel or Aluminum as indicated on plan
 3. Finish: Baked enamel, white.

1.23 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

PART 2 - EXECUTION

2.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- J. Install fire and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements for fire and smoke dampers and specific installation requirements of the damper UL listing. Rating of walls, ceilings, partitions, and floors shall be maintained at duct penetrations.
- K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- M. Elbows: Use long-radius elbows where coordination allows.
 - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
 - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.
- N. Branch Connections: Use lateral or conical branch connections.
- O. Provide 1/2" x 1/2" aluminum wire mesh on all open ended ducts, concealed or exposed. Requirement does not apply to transfer ducts.
- P. Plenums and Connections to Louvers:
 - 1. Shall be 18 ga. minimum cross-broken and properly reinforced with galvanized angle irons to SMACNA requirements.
 - 2. Shall have bottom and corner seams soldered watertight at least 12" up from bottom.
 - 3. Shall have neoprene gaskets or other non-corrodible material to make connections to louvers watertight.
 - 4. Shall pitch connection back towards the louver. Provide half-coupling drain connection at bottom of plenum unless noted otherwise. Pipe drain to nearest floor drain.
 - 5. Shall have unused portions of louvers blocked-off with insulated louver blank off panels; sealed air and watertight.
 - 6. Provide and install bird or insect screen.

2.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in 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.

2.3 AIR DUCT ACCESSORY INSTALLATION

- A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

- C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel. Volume dampers shall match connected duct material.
- F. Manual volume dampers are not shown on plan for drawing clarity. Provide manual volume dampers at all low-pressure supply, return, and exhaust branches; and also at all register, grille, and diffuser takeoff. Volume dampers shall be installed in branch takeoff.
- G. Set dampers to fully open position before testing, adjusting, and balancing.
- H. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
- I. Install fire and smoke dampers in accordance with UL listing.
- J. 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 and downstream 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. At each change in direction and at maximum 50-ft. spacing.
 - 8. Upstream and downstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. For grease ducts, install at locations and spacing as required by NFPA 96.
 - 11. Control devices requiring inspection.
 - 12. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
- L. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.

- M. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- N. Install flexible connectors to connect ducts to equipment.
- O. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

2.4 FLEXIBLE DUCT INSTALLATION

- A. Install flexible ducts 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. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect terminal units without fans to supply and return ducts directly. Connect terminal units with fans to supply and return ducts with flexible connectors.
- D. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with nylon draw bands or reusable stainless steel draw bands. Nylon draw bands shall be installed with manufacturer clamping tool.
- F. Install duct test holes where required for testing and balancing purposes.
- G. Installation:
 - 1. Install ducts fully extended.
 - 2. Do not bend ducts across sharp corners.
 - 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 - 5. Install flexible ducts in a direct line, without sags, twists, or turns.
- H. Supporting Flexible Ducts:
 - 1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
 - 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
 - 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
 - 4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

2.5 DIFFUSER, REGISTER AND GRILLE INSTALLATION

- A. Install diffusers 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 practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing. Perimeter linear slot diffusers shall be deflected towards perimeter. Opposing diffusers shall be adjusted to prevent downdraft into occupied zone.

2.6 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

2.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 23 05 48 "Vibration and Seismic Controls for HVAC."
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- 2.8 DUCTWORK CONNECTIONS
- A. Make connections to motorized equipment with flexible connectors.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
- 2.9 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.
- 2.10 FIELD QUALITY CONTROL
- A. Perform tests and inspections.
- B. Leakage Tests:
1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 2. Test the following systems:
 - a. Outdoor-Air Ducts with a Pressure Class of 2- Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
 5. Test for leaks before applying external insulation.

6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 7. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.
- D. Air Duct Accessory Tests and Inspections
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
 5. Operate remote damper operators to verify full range of movement of operator and damper.
- E. Duct system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- 2.11 STARTUP
- A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
- 2.12 DUCT SCHEDULE
- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
 2. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.
- B. Supply Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and downstream of Terminal Units:
 - a. Pressure Class: Minimum Positive 2-inch wg or 125% of scheduled fan external static pressure.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.

2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Minimum Positive 2-inch wg or 125% of scheduled fan external static pressure.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
- C. Return Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and upstream of return terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg or 125% of scheduled fan external static pressure.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Minimum Negative 2-inch wg or 125% of scheduled fan external static pressure.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
- D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Minimum negative 2-inch wg or 125% of scheduled fan external static pressure
 - b. Minimum SMACNA Seal Class: A if negative or positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
 2. Relief Ducts Connected to Air-Handling Units or Energy Recovery Units:
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.

- F. Ducts and Systems not listed
1. Ducts Connected to Equipment or Systems Not Listed Above:
 - a. Pressure Class: Negative or Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 2.
 - d. SMACNA Leakage Class for Round and Flat Oval: 2.
- G. Liner:
1. Supply-Air Ducts: Fibrous glass, Type I, 1 inch thick.
 2. Return-Air Ducts: Fibrous glass, Type I, 1 inch thick.
 3. Exhaust-Air Ducts: Fibrous glass, Type I, 1 inch thick.
- H. Elbow Configuration: Comply with the referenced figures in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Rectangular Duct -Use only the following fittings from Figure 4-2, "Rectangular Elbows" from SMACNA "Duct Construction Manual." Priority shall be given to full radius type elbows. Square throat elbows with turning vanes (Type RE-2) are only allowed when shown on design documents. Refer to "Turning Vanes" under Part 2 – Products for additional information.
 - a. Type RE 1: Radius elbow, where the inside elbow radius is equal to the width of the duct in plane of the elbow.
 - b. Type RE 3: Radius elbow with full length turning vanes. R is equal to inside elbow radius. W is equal to width of the duct in plane of the elbow.
 - 1) $1 > R/W \geq 0.5$: One splitter vane
 - 2) $0.5 > R/W \geq 0.25$: Two splitter vanes
 - 3) $0.25 > R/W > 0.05$: Three splitter vanes
 - 4) Where two elbows are less than 2 equivalent duct diameters away, increase quantity of splitter vanes up to maximum of three.
 - c. Type RE 5: Dual radius elbow
 - d. Type RE 6: Mitered elbow. Only to be used where angle is 15 degrees or less.
 2. Round Duct: Comply with Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam for non-welded ductwork. Provide welded elbows in welded ductwork.

- I. Branch Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Conical, bellmouth, and 45 degree lead in.
 - 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 0 to 1250 fpm: Conical tap.
 - b. Velocity 1250 fpm or Higher: 45-degree lateral.
- J. Divided Flow Branches
 - 1. Comply with the following types identified in Figure 4-5 of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Type 1
 - b. Type 3
 - c. Type 4A (without square throat elbow)
 - d. Type 4B (without square throat elbow)
- K. Offsets and Transitions
 - 1. All types shown in Figure 4-7 of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." are acceptable.
- L. Obstructions
 - 1. Comply with the following types identified in Figure 4-8 of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Figure A, B, C, and E

END OF SECTION 23 31 13

SECTION 23 72 23 - PACKAGED ENERGY RECOVERY UNITS**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Packaged, indoor, heat-wheel energy-recovery units.
2. Packaged, outdoor, heat-wheel, energy-recovery units.
3. Packaged, indoor, fixed-plate total energy-recovery units.
4. Packaged, outdoor, fixed-plate total energy-recovery units.

1.3 ACTION SUBMITTALS

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

1. Include packaged, indoor, heat wheel, energy-recovery-unit rated capacities, operating characteristics, furnished specialties, and accessories.
2. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.

- B. Sustainable Design Submittals:

1. [Product data showing compliance with](#) ASHRAE 62.1.
2. [Laboratory Test Reports](#): For antimicrobial coatings, indicating compliance with requirements for low-emitting materials.

- C. Shop Drawings: For air-to-air energy recovery equipment.

1. Include plans, elevations, sections, details, mounting, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

- D. Delegated-Design Submittal: For air-to-air energy-recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of air-to-air energy-recovery equipment.

2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration-isolation bases.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, roof plans, elevations, and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-to-air energy-recovery equipment to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: One set(s) of each type of filter specified.
 2. Fan Belts: One set(s) of belts for each belt-driven fan in energy-recovery units.
 3. Wheel Belts: One set(s) of belts for each heat wheel.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, indoor, heat wheel energy-recovery units that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Packaged Energy-Recovery Units: One years from date of Substantial Completion.
 2. Warranty Period for Energy-Recovery Wheel/Core: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- B. ASHRAE Compliance:
 1. Applicable requirements in ASHRAE 62.1.
 2. Capacity ratings for air-to-air energy-recovery equipment shall comply with ASHRAE 84.
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

- D. UL Compliance:
 - 1. Packaged heat-recovery ventilators shall comply with requirements in UL 1812 or UL 1815.
 - 2. Electric coils shall comply with requirements in UL 1995.

- E. Comply with ASTM E84 or UL 723.

2.2 PACKAGED, INDOOR, HEAT WHEEL ENERGY-RECOVERY UNITS

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

- 1. [Greenheck Fan Corporation](#).
- 2. Swegon.
- 3. [Systemair USA](#).
- 4. Valent.
- 5. [YORK; brand of Johnson Controls International plc, Building Solutions North America](#).

- B. Source Limitations: Obtain packaged, indoor, heat wheel energy-recovery units from single manufacturer.

- C. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

- D. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, gasketed hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 2 inch-thick, R-13 thermal insulation, knockouts for electrical connections, exterior drain connection, and lifting lugs. Double wall construction, 20ga interior and exterior.

- E. Heat Wheel:

- 1. Casing:
 - a. Manufacturer's standard construction with standard factory finish.
 - b. Slide-in, slide-out cassette style for easy access.
 - c. Casing seals on periphery of rotor and on duct divider and purge section.
 - d. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings with an L-50 of 200,000 hours. Support horizontal rotors on tapered roller bearing.
- 2. Rotor: Corrosion-resistant aluminum alloy, composed of alternating corrugated and flat, continuously wound layers of uniform width that guarantee laminar air flow and low static pressure loss.
- 3. Counter-flow construction type.
- 4. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable-frequency motor controller and self-adjusting multilink belt around outside of rotor.
 - a. Comply with motor NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in 230500 "Common Work Results for HVAC."
 - b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

- F. Supply and Exhaust Fans: Backward inclined fan with spring isolators of 1-inch static deflection.

1. Motor and Drive: Direct driven, with speed changed by variable-frequency motor controller.
2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. UL Compliance: Comply with UL 900.
3. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
4. Filter Media Frame: Beverage board with perforated metal retainer or metal grid on outlet side.
5. Filter-Mounting Frames: Arranged with access doors or panels on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

H. Electric Coils:

1. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service.
2. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
3. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout safety device; serviceable through terminal box without removing heater from coil section.
4. Secondary Protection: Load-carrying, manually resetting or manually replaceable thermal cutouts; factory wired in series with each heater stage.
5. Control Panel: Unit mounted with disconnecting means and overcurrent protection.
 - a. Solid-state, stepless SCR controller.
 - b. Time-delay relay.
 - c. Pilot lights:
 - 1) One per step for step-controlled coils.
 - d. Airflow proving switch.

I. Wiring: Fabricate units with space within housing for electrical conduits. Wire motors and controls, so only external connections are required during installation.

1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
2. Include nonfused disconnect switches.

2.3 CONTROLS

- A. Control Panel: Solid-state, programmable, microprocessor-based control unit for wall mounting. Integrate to BACnet as specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC".
- B. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
- C. Frost Control: Electric preheat.

- D. Economizer Control: Stop wheel rotation or modulate wheel rotation when conditions are favorable for economizer operation.
- E. Enthalpy sensor.
- F. Temperature Sensors: Four stainless steel temperature sensors for monitoring supply and exhaust air in and air out, maximizing units efficiency and detecting need for frost prevention.
- G. Rotation sensor and alarm.
- H. Dirty filter switch.
- I. Low-Voltage Transformer: Integral transformer to provide control voltage to unit from primary incoming electrical service.
- J. Electric Coil Controls:
 - 1. Factory-mounted sensor in outside-air intake with sensor adjustment located in control panel to control electric coil and maintain minimum entering temperature, to avoid frost formation.
- K. Variable-Frequency Motor Controller: Serving wheel rotation motor.

2.4 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended application.
- B. AHRI Compliance: Capacity ratings for air-to-air energy-recovery equipment certified as complying with AHRI 1060.
- C. Fan Performance Rating: Comply with AMCA 211 and label fans with AMCA-certified rating seal. Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency according to AMCA 210/ASHRAE 51.
- D. Fan Sound Rating: Comply with AMCA 301 or AHRI 260 (IP). Air-handling unit fan sound ratings shall comply with AMCA 301 or AHRI 260 (IP).
- E. UL Compliance:
 - 1. Packaged heat recovery ventilators shall comply with requirements in UL 1812 or UL 1815.
 - 2. Electric Coils: Comply with UL 1995.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before packaged, indoor, heat wheel energy-recovery unit installation. Replace with new insulation materials any filter media that are wet, moisture damaged, or mold damaged.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install energy-recovery units, so supply and exhaust airstreams flow in opposite directions, and rotation is away from exhaust side to purge section to supply side.
 - 1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
 - 2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
 - 3. Access doors and panels are specified in Section 23 33 00 "Air Duct Accessories."
- B. Equipment Mounting:
 - 1. Install packaged, indoor, energy-recovery units on storage room floor.
 - 2. Comply with requirements for vibration-isolation devices specified in Section 23 05 48 "Vibration Controls for HVAC."
- C. Install units with clearances for service and maintenance.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

3.3 DUCTWORK CONNECTIONS

- A. Comply with requirements for ductwork according to Section 23 31 13 "Air Distribution Systems - Metal Ducts." Connect duct to units with flexible connections.
- B. Isolation Dampers: Install motorized isolation dampers.

3.4 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished with units but not factory mounted.
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Packaged energy-recovery equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

- A. Adjust moving parts to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature and humidity set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy-recovery units.

END OF SECTION 23 72 23

SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01, and Division 20 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.
 - 3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: One year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Daikin.
 - 2. Carrier Global Corporation.
 - 3. Lennox Industries, Inc.; Lennox International.
 - 4. Mitsubishi Electric & Electronics USA, Inc.
 - 5. Samsung HVAC.
 - 6. Trane.
 - 7. YORK; brand of Johnson Controls International plc, Building Solutions North America.

2.2 INDOOR, RECESSED, CEILING-MOUNTED UNITS

- A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
- B. Cabinet:
1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
 2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
 3. Mounting: Manufacturer-designed provisions for field installation.
 4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. DX Coil Assembly:
1. Coil Casing: Aluminum, galvanized, or stainless steel.
 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
 3. Coil Tubes: Copper, of diameter and thickness required by performance.
 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
 5. Internal Tubing: Copper tubing with brazed joints.
 6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 7. Field Piping Connections: Manufacturer's standard.
 8. Factory Charge: Dehydrated air or nitrogen.
 9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
 2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
 3. Field Piping Connection: Non-ferrous material.
- E. Fan and Motor Assembly:
1. Fan(s):
 - a. Direct-drive arrangement.
 - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
 - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
 - d. Wheels statically and dynamically balanced.
 2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
 3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
 5. Vibration Control: Integral isolation to dampen vibration transmission.

- F. Filter Assembly:
1. Access: Bottom, to accommodate filter replacement without the need for tools.
 2. Efficiency: ASHRAE 52.2, MERV 13.
 3. Media:
 - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
- G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.
1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
 - a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
 - b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.
 2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
 3. Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one additional supply branch duct.
- H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.
- I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.
- J. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
 2. Factory-Installed Controller: Configurable digital control.
 3. Factory-Installed Sensors: Unit inlet air temperature, Coil entering refrigerant temperature, and Coil leaving refrigerant temperature.
 4. Field-Customizable I/O Capability:
 - a. Analog Inputs: Two for use in customizable control strategies.
 - b. Digital Inputs: Four for use in customizable control strategies.
 - c. Digital Outputs: Three for use in customizable control strategies.
 5. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, and run test switch.
 6. Communication: Network communication with other indoor units and outdoor unit(s).
 7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
- K. Unit Electrical:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
 2. Field Connection: Single point connection to power entire unit and integral controls.
 3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, 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 device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
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 5 deg F.
7. Mounting Base: 18" high snow stand, powder coated steel with neoprene isolators.

2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Division 23 "Direct Digital Control (DDC) System for HVAC" and Division 23 "Sequence of Operations for HVAC DDC."
- B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
 1. Compressor time delay.
 2. 24-hour time control of system stop and start.
 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 4. Fan-speed selection including auto setting.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Monitoring:
 1. Monitor constant and variable motor loads.
 2. Monitor variable-frequency-drive operation.
 3. Monitor economizer cycle.
 4. Monitor cooling load.
 5. Monitor air distribution static pressure and ventilation air volumes.

2.5 SYSTEM REFRIGERANT PIPING

A. Refrigerant Piping:

1. Copper Tube: ASTM B280, Type ACR.
2. Wrought-Copper Fittings: ASME B16.22.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

B. Refrigerant Tubing Kits:

1. Furnished by split system system manufacturer.
2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
3. Standard one-piece length for connecting to indoor units.
4. Pre-insulated with flexible elastomeric 1/2 thick insulation. Provide aluminum jacket w/ moisture barrier cut and rolled to size for outdoor piping. Secure jacket with stainless steel band clamps.
5. Factory Charge: Dehydrated air or nitrogen.

C. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
3. Valve Connections: Flare or sweat depending on size.

2.6 SYSTEM CONDENSATE DRAIN PIPING

A. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B88, Type L or Type DWV according to ASTM B306.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.

2.7 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized or copper-coated steel.

2.8 PIPING AND TUBING INSULATION

A. Flexible Elastomeric Insulation (1/2" thickness for <1 NPS piping): Closed-cell, or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I, for tubular materials, Type II for sheet materials.

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

- a. Aeroflex USA.
- b. [Armacell LLC](#).
- c. [K-Flex USA](#).

B. Flexible Elastomeric Adhesive: Solvent-based adhesive.

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

- a. Aeroflex USA.
- b. [Armacell LLC](#).
- c. [K-Flex USA](#).

2. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F.
4. Service Temperature Range: 40 to 200 deg F.
5. Color: Black.

C. Metal Jacket – Required for outdoor installation

1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. 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: 53-mil-thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

2.9 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or stainless steel.
2. Outdoor Applications: Stainless steel.

2.10 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [MIRO Industries Inc.](#)
 - b. [PHP Systems/Design.](#)
 - c. [RectorSeal HVAC; a CSW Industrials Company.](#)
 - d. [Rooftop Support Systems; Eberl Iron Works, Inc.](#)
 2. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 4. Hardware: Galvanized steel or polycarbonate.
 5. Accessories: Protection pads.
- C. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.11 OUTDOOR EQUIPMENT STANDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [MIRO Industries Inc.](#)
 2. [RectorSeal HVAC; a CSW Industrials Company.](#)
 3. [Rooftop Support Systems; Eberl Iron Works, Inc.](#)
- B. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof-supported outdoor equipment components, without roof membrane penetration, in a prefabricated system that can be modularly assembled on-site.
- C. Foot Material: Rubber or polypropylene.
- D. Rails Material: Hot-dip galvanized carbon steel.
- E. Wind/Sliding Load Resistance: Up to 125 mph minimum. Equipment shall be anchored to roof. Provide anchor points to existing structure through roofing membrane for stainless steel tie-down cable attachment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install outdoor units on support structures indicated on Drawings.
- C. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- D. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- E. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 "Cast-in-Place Concrete."
 - 2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
 - 3. Comply with requirements for vibration isolation and seismic control devices specified in Division 23 "Vibration, Wind and Seismic Controls for HVAC."
- F. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Water Coil Connections: Comply with requirements specified in Division 23 "Hydronic Piping" and Division 23 "Hydronic Piping Specialties." Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
 - 2. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Division 23 "Hydronic Piping" and Division 23 "Hydronic Piping Specialties." Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Division 23 "Air Distribution Systems – Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 "Air Distribution Systems – Metal Ducts."

3.3 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

- A. General Requirements for Drain Piping and Tubing:
 - 1. Install a union in piping at each threaded unit connection.

2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
 - a. Details indicated on Drawings.
 - b. Manufacturer's requirements.
 - c. Governing codes.
 - d. In the absence of requirements, comply with requirements of ASHRAE handbooks.
4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.4 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet. Minimum rod size, 1/4 inch.
3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Refrigerant piping install shall satisfy manufacturer's minimum straight run requirements at indoor unit connections.

G. Install refrigerant piping and tubing in protective conduit where installed belowground.

- H. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.
- I. Unless otherwise required by system manufacturer, slope refrigerant piping and tubing as follows:
 - 1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- J. When brazing, remove or protect components that could be damaged by heat.
- K. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.
- L. Joint Construction:
 - 1. Ream ends of tubes and remove burrs.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
 - 3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
 - a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
 - b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.5 INSTALLATION OF METAL HANGERS AND SUPPORTS

- A. Comply with requirements in Division 23 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- B. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Comply with MFMA-103 for metal framing system selections and applications that are not specified.
- E. 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.
 - 2. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel.
 - 1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Piping and Tubing Insulation:
 - 1. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 2. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
- N. Horizontal-Piping Hangers and Supports: Install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 4. Multiple horizontal pipes located indoors may use metal framing systems with split clamp attachment for each pipe in lieu of individual clevis hangers.
 - 5. Pipe stands for horizontal pipes located outdoors.
 - 6. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 7. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- O. Horizontal Piping Hanger Spacing and Rod Size: Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:
 - 1. Sizes through NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

- P. Vertical-Piping Clamps: Install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): If longer ends are required for riser clamps.
- Q. Support vertical runs at roof, at each floor, and at midpoint intervals between floors, not to exceed 10 feet.
- R. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified.
- S. Use hangers, supports, and attachments with galvanized coatings unless otherwise indicated.
- T. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- U. Trim excess length of continuous-thread hanger and support rods to 1 inch.

3.6 INSTALLATION OF PIPING AND TUBING INSULATION

- 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. Installation to maintain a continuous vapor barrier.
- B. 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.
- C. 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 unavailable, 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. 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.
- D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. 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.
- E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 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.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.8 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 26 00 10 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section specifies supplemental requirements generally applicable to the Work specified in Division 26. This Section is also referenced by related Work specified in other Divisions.
- B. Related Requirements:
 - 1. Section 26 00 11 "Facility Performance Requirements for Electrical" specifies seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 REFERENCES

- A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:
 - 1. 8P8C: An 8-position 8-contact modular jack.
 - 2. A: Ampere, unit of electrical current.
 - 3. AC or ac: Alternating current.
 - 4. AFCI: Arc-fault circuit interrupter.
 - 5. AIC: Ampere interrupting capacity.
 - 6. AL, Al, or ALUM: Aluminum.
 - 7. ASD: Adjustable-speed drive; also called "variable-frequency drive" (VFD).
 - 8. ATS: Automatic transfer switch.
 - 9. AWG: American wire gauge; see ASTM B258.
 - 10. BAS: Building automation system.
 - 11. BIL: Basic impulse insulation level.
 - 12. BIM: Building information modeling.
 - 13. CAD: Computer-aided design or drafting.
 - 14. CATV: Community antenna television.
 - 15. CB: Circuit breaker.
 - 16. cd: Candela, the SI fundamental unit of luminous intensity.
 - 17. CO/ALR: Copper-aluminum, revised.
 - 18. COPS: Critical operations power system.
 - 19. CU or Cu: Copper.
 - 20. CU-AL or AL-CU: Copper-aluminum.
 - 21. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
 - 22. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
 - 23. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
 - 24. dBm: Decibel absolute power with respect to 1 mW.
 - 25. DC or dc: Direct current.
 - 26. DCOA: Designated critical operations area.
 - 27. DDC: Direct digital control (HVAC).
 - 28. EGC: Equipment grounding conductor.
 - 29. ELV: Extra-low voltage.
 - 30. EMF: Electromotive force.
 - 31. EMI: Electromagnetic interference.

32. EPM: Electrical preventive maintenance.
33. EPS: Emergency power supply.
34. EPSS: Emergency power supply system.
35. ESS: Energy storage system.
36. EV: Electric vehicle.
37. EVPE: Electric vehicle power export equipment.
38. EVSE: Electric vehicle supply equipment.
39. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion $1 \text{ fc} = 10 \text{ lx}$ in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
40. FLC: Full-load current.
41. FLA: Full-load amperage.
42. ft: Foot.
43. ft-cd: Foot-candle, the antiquated U.S. Standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" after the SI unit candela (cd) replaced the international candle; see "fc,"
44. GEC: Grounding electrode conductor.
45. GFCI: Ground-fault circuit interrupter.
46. GFPE: Ground-fault protection of equipment.
47. GND: Ground.
48. HACR: Heating, air conditioning, and refrigeration.
49. HDPE: High-density polyethylene.
50. HID: High-intensity discharge.
51. HP or hp: Horsepower.
52. HVAC: Heating, ventilating, and air conditioning.
53. Hz: Hertz.
54. IBT: Intersystem bonding termination.
55. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
56. IP: Ingress protection rating (enclosures); Internet protocol (communications).
57. IR: Infrared.
58. IS: Intrinsically safe.
59. IT&R: Inspecting, testing, and repair.
60. ITE: Information technology equipment.
61. kAIC: Kiloampere interrupting capacity.
62. kcmil or MCM: One thousand circular mils.
63. kV: Kilovolt.
64. kVA: Kilovolt-ampere.
65. kVA_r or kVAR: Kilovolt-ampere reactive.
66. kW: Kilowatt.
67. kWh: Kilowatt-hour.
68. LAN: Local area network.
69. lb: Pound (weight).
70. lbf: Pound (force).
71. LCD: Liquid-crystal display.
72. LCDI: Leakage-current detector-interrupter.
73. LED: Light-emitting diode.
74. Li-ion: Lithium-ion.
75. lm: Lumen, the SI derived unit of luminous flux.
76. LNG: Liquefied natural gas.
77. LP-Gas: Liquefied petroleum gas.
78. LRC: Locked-rotor current.

79. LV: Low voltage.
80. lx: Lux, the SI derived unit of illuminance equal to one lumen per square meter.
81. m: Meter.
82. MCA: Minimum circuit ampacity
83. MCC: Motor-control center.
84. MDC: Modular data center.
85. MG set: Motor-generator set.
86. MIDI: Musical instrument digital interface.
87. MLO: Main lugs only.
88. MV: Medium voltage.
89. MVA: Megavolt-ampere.
90. mW: Milliwatt.
91. MW: Megawatt.
92. MWh: Megawatt-hour.
93. NC: Normally closed.
94. Ni-Cd: Nickel-cadmium.
95. Ni-MH: Nickel-metal hydride.
96. NIU: Network interface unit.
97. NO: Normally open.
98. NPT: National (American) standard pipe taper.
99. OCPD: Overcurrent protective device.
100. ONT: Optical network terminal.
101. PC: Personal computer.
102. PCS: Power conversion system.
103. PCU: Power-conditioning unit.
104. PF or pf: Power factor.
105. PHEV: Plug-in hybrid electric vehicle.
106. PLC: Programmable logic controller.
107. PLFA: Power-limited fire alarm.
108. PoE: Power over Ethernet.
109. PV: Photovoltaic.
110. PVC: Polyvinyl chloride.
111. pW: Picowatt.
112. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
113. RMS or rms: Root-mean-square.
114. RPM or rpm: Revolutions per minute.
115. SCADA: Supervisory control and data acquisition.
116. SCR: Silicon-controlled rectifier.
117. SPD: Surge protective device.
118. sq.: Square.
119. SWD: Switching duty.
120. TCP/IP: Transmission control protocol/Internet protocol.
121. TEFC: Totally enclosed fan-cooled.
122. TR: Tamper resistant.
123. TVSS: Transient voltage surge suppressor.
124. UL: (standards) Underwriters Laboratories, Inc.; (product categories) UL, LLC.
125. UL CCN: UL Category Control Number.
126. UPS: Uninterruptible power supply.
127. USB: Universal serial bus.
128. UV: Ultraviolet.
129. V: Volt, unit of electromotive force.
130. V(ac): Volt, alternating current.

131. V(dc): Volt, direct current.
132. VA: Volt-ampere, unit of complex electrical power.
133. VAR: Volt-ampere reactive, unit of reactive electrical power.
134. VFC: Variable-frequency controller.
135. VFD: Variable-frequency drive.
136. VOM: Volt-ohm-multimeter.
137. VPN: Virtual private network.
138. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
139. W: Watt, unit of real electrical power.
140. Wh: Watt-hour, unit of electrical energy usage.
141. WPT: Wireless power transfer.
142. WPTTE: Wireless power transfer equipment.
143. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. CR: Communications raceway.
2. CR-GP: General-purpose communications raceway.
3. CR-P: Plenum communications raceway.
4. CR-R: Riser communications raceway.
5. EMT: Electrical metallic tubing.
6. EMT-A: Aluminum electrical metallic tubing.
7. EMT-S: Steel electrical metallic tubing.
8. EMT-SS: Stainless steel electrical metallic tubing.
9. ENT: Electrical nonmetallic tubing.
10. EPEC: Electrical HDPE underground conduit (thin wall).
11. EPEC-A: Type A electrical HDPE underground conduit.
12. EPEC-B: Type B electrical HDPE underground conduit.
13. ERMC: Electrical rigid metal conduit.
14. ERMC-A: Aluminum electrical rigid metal conduit.
15. ERMC-S: Steel electrical rigid metal conduit.
16. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
17. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
18. ERMC-SS: Stainless steel electrical rigid metal conduit.
19. FMC: Flexible metal conduit.
20. FMC-A: Aluminum flexible metal conduit.
21. FMC-S: Steel flexible metal conduit.
22. FMT: Steel flexible metallic tubing.
23. FNMC: Flexible nonmetallic conduit. See "LFNC."
24. HDPE: HDPE underground conduit (thick wall).
25. HDPE-40: Schedule 40 HDPE underground conduit.
26. HDPE-80: Schedule 80 HDPE underground conduit.
27. IMC: Steel electrical intermediate metal conduit.
28. LFMC: Liquidtight flexible metal conduit.
29. LFMC-A: Aluminum liquidtight flexible metal conduit.
30. LFMC-S: Steel liquidtight flexible metal conduit.
31. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
32. LFNC: Liquidtight flexible nonmetallic conduit.
33. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
34. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
35. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.

36. OFR: Optical fiber raceway.
37. OFR-GP: General-purpose optical fiber raceway.
38. OFR-P: Plenum optical fiber raceway.
39. OFR-R: Riser optical fiber raceway.
40. PVC: Rigid PVC conduit.
41. PVC-40: Schedule 40 rigid PVC conduit.
42. PVC-80: Schedule 80 rigid PVC Conduit.
43. PVC-A: Type A rigid PVC concrete-encased conduit.
44. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
45. RGS: See ERM-C-S-G.
46. RMC: See ERM-C.
47. RTRC: Reinforced thermosetting resin conduit.
48. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
49. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
50. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
51. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
52. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.

31. MI: Mineral-insulated, metal-sheathed cable.
32. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
37. NPLF: Non-power-limited fire-alarm circuit cable.
38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
39. NPLFR: Non-power-limited fire-alarm circuit riser cable.
40. NUCC: Nonmetallic underground conduit with conductors.
41. OFC: Conductive optical fiber general-purpose cable.
42. OFCG: Conductive optical fiber general-purpose cable.
43. OFCP: Conductive optical fiber plenum cable.
44. OFCR: Conductive optical fiber riser cable.
45. OFN: Nonconductive optical fiber general-purpose cable.
46. OFNG: Nonconductive optical fiber general-purpose cable.
47. OFNP: Nonconductive optical fiber plenum cable.
48. OFNR: Nonconductive optical fiber riser cable.
49. P: Marine shipboard cable.
50. PLTC: Power-limited tray cable.
51. PLTC-ER: Power-limited tray cable, exposed run.
52. PV: Photovoltaic cable.
53. RHH: (high heat) Thermoset rubber, heat-resistant cable.
54. RHW: Thermoset rubber, moisture-resistant cable.
55. SA: Silicone rubber cable.
56. SE: Service-entrance cable.
57. SER: Service-entrance cable, round.
58. SEU: Service-entrance cable, flat.
59. SIS: Thermoset cable for switchboard and switchgear wiring.
60. TBS: Thermoplastic cable with outer braid.
61. TC: Tray cable.
62. TC-ER: Tray cable, exposed run.
63. TC-ER-HL: Tray cable, exposed run, hazardous location.
64. THW: Thermoplastic, heat- and moisture-resistant cable.
65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
66. THHW: Thermoplastic, heat- and moisture-resistant cable.
67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
68. TW: Thermoplastic, moisture-resistant cable.
69. UF: Underground feeder and branch-circuit cable.
70. USE: Underground service-entrance cable.
71. XHH: Cross-linked polyethylene, heat-resistant cable.
72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations and Acronyms for Electrical Flexible Cord Types:

1. SEO: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.
2. SEOW: 600 V extra-hard-usage, hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
3. SEOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp locations.

4. SEOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer covering for damp or wet locations.
5. SJEO: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
6. SJEOW: 300 V hard-usage, junior hard-service cord with thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
7. SJEOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp locations.
8. SJEOWW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic elastomer insulation and oil-resistant thermoplastic elastomer outer cover for damp or wet locations.
9. SJO: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp locations.
10. SJOW: 300 V hard-usage, junior hard-service cord with thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
11. SJOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp locations.
12. SJOWW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer cover for damp or wet locations.
13. SJTO: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
14. SJTOW: 300 V hard-usage, junior hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
15. SJTOO: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp locations.
16. SJTOOW: 300 V hard-usage, junior hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer cover for damp or wet locations.
17. SO: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp locations.
18. SOW: 600 V extra-hard-usage, hard-service cord with thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
19. SOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp locations.
20. SOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoset insulation and oil-resistant thermoset outer covering for damp or wet locations.
21. STO: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
22. STOW: 600 V extra-hard-usage, hard-service cord with thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.
23. STOO: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp locations.
24. STOOW: 600 V extra-hard-usage, hard-service cord with oil-resistant thermoplastic insulation and oil-resistant thermoplastic outer covering for damp or wet locations.

E. Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."
 - a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.

2. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
3. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
4. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
5. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
6. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
7. Designated Seismic System: A system component that requires design in accordance with Ch. 13 of ASCE/SEI 7 and for which the Component Importance Factor is greater than 1.0.
8. Direct Buried: Installed underground without encasement in concrete or other protective material.
9. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
 - a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
 - b. Concrete Box: A box intended for use in poured concrete.
 - c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 - d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
 - e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
 - f. Device Box: A box with provisions for mounting a wiring device directly to the box.
 - g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
 - h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
 - i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
 - j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
 - k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
 - l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an

- outlet box cover, but without provisions for mounting a wiring device directly to the box.
- m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
 - n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
 - o. Raised-Floor Box: A floor box intended for use in raised floors.
 - p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
 - q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
 - r. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
 - s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
 - t. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
10. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
11. Essential Electrical Systems: (healthcare facilities) Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system.
12. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.
- a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.
13. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
14. Jacket: A continuous nonmetallic outer covering for conductors or cables.
15. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
16. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
17. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
18. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

19. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
20. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
21. Sheath: A continuous metallic covering for conductors or cables.
22. UL Category Control Number (CCN): An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
23. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
 - b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
 - c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
 - d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
 - e. Medium Voltage (MV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
 - f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.
24. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

1.3 COORDINATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
 1. Notify Architect no fewer than fourteen days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Architect's written permission.
 3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
 - a. Emergency lighting.
 - b. Elevators.
 - c. Fire-alarm systems.
- B. Arrange to provide temporary electrical power in accordance with requirements specified in Division 01.

1.4 PREINSTALLATION MEETINGS

- A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than 10 days after notice to proceed. Agenda topics include, but are not limited to, the following:
 - 1. Electrical installation schedule.
 - 2. Status of power system studies.
 - 3. Value analysis proposals and requests for substitution of electrical equipment.
 - 4. Utility work coordination and class of service requests.
 - 5. Commissioning activities.
 - 6. Sustainability activities.

1.5 SEQUENCING

- A. Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

1.6 ACTION SUBMITTALS

- A. Coordination drawings.

1.7 INFORMATIONAL SUBMITTALS

- A. Electrical installation schedule.
- B. Qualification statements.
- C. Welding certificates.

1.8 CLOSEOUT SUBMITTALS

- A. Facility EPM program binders.
- B. Operation and maintenance data.
- C. Software and firmware operational documentation.
- D. Software.

1.9 QUALITY ASSURANCE

- A. Qualifications: Prepare and submit qualification statements for the following entities performing Work on Project:
 - 1. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 01 40 00 "Quality Requirements," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.
 - 2. Electrical Professional Engineer: Professional engineer possessing active qualifications specified in Section 01 40 00 "Quality Requirements," with expertise in electrical engineering, including electrical power system modeling and analysis of electrical safety in accordance with NFPA 70E.

3. EPM Specialist: Recognized experts possessing the following qualifications in accordance with Section 01 40 00 "Quality Requirements" and NFPA 70B:
 - a. Technical Competence: Person should, by education, training, and experience, be well-rounded in all aspects of electrical maintenance.
 - b. Administrative and Supervisory Skills: Person should be skilled in planning and development of long-range objectives to achieve specific results and should be able to command respect and solicit cooperation of persons involved in EPM Program development.
4. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.
5. Medium-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - a. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.10 MOCKUPS

- A. Simple Mockups for Coordinating Accessibility of Electrical Devices around Fixed Furnishings and Equipment:
 1. Build simple mockups using art supplies and other inexpensive materials for verification of general arrangement, actual dimensions, and accessibility of Video wall equipment, and floor outlet pod connections by Architect prior to fabrication and installation of Work. Depict products from all Divisions requiring coordination including, but not limited to, fixed furnishings, casework, outlet covers and plates, exposed raceway, exposed plumbing, equipment, and signage.
- B. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

1.11 FIELD CONDITIONS

- A. Modeling, analysis, product selection, installation, and quality control for Work specified in Division 26 must comply with requirements specified in Section 26 00 11 "Facility Performance Requirements for Electrical."

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

- A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Notification of Contractor's intent to request substitutions for convenience must be declared during the Electrical Preconstruction Conference so potential risks to system performance and construction schedule may be identified for Contractor's response in submission of the substitution request. Submission of requests for substitutions for convenience must meet the conditions and deadline specified in Section 01 25 00 "Substitution Procedures" to receive approval.
2. For electrical equipment and systems, substitutions for cause are considered major construction risks. If it is possible that Contractor may need to request substitutions for cause because of equipment unavailability, or inability to meet construction schedule because of lead time, Contractor must declare the possibility during the Electrical Preconstruction Conference to permit establishing a mitigation plan for minimizing risks to system performance and construction schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. The contractor shall be responsible for pre-bid site inspections for project familiarization.

3.2 PREPARATION

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 26.
4. Orders placed for major electrical equipment.
5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Mockup reviews.
8. Closing of walls and ceilings containing electrical Work.
9. System startup, testing, and commissioning activities for major electrical equipment.
10. System startup, testing, and commissioning activities for emergency lighting.
11. System startup, testing, and commissioning activities for automation systems (lighting, HVAC, fire alarm, etc.).
12. Requests for special inspections.
13. Requests for inspections by authorities having jurisdiction.

B. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.

C. Coordination Drawings for Ceiling Areas: Where indicated on Drawings, provide reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 01 31 00 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which equipment, luminaires, and suspension systems will be attached.
 3. Size and location of access panels on ceilings.
 4. Elevation, size, and route of sprinkler piping.
 5. Elevation, size, and route of plumbing piping.
 6. Elevation, size, and route of ductwork.
 7. Elevation, size, and route of cable tray.
 8. Elevation, size, and route of conduit.
 9. Elevation and size of wall-mounted and ceiling-mounted equipment.
 10. Moldings.
 11. Access panels.
 12. Sprinklers.
 13. Air inlets and outlets.
 14. Control modules.
 15. Luminaires.
 16. Communications devices.
 17. Speakers.
 18. Ceiling-mounted projectors.
 19. Security devices.
 20. Fire-alarm devices.
 21. Indicate clear dimensions for maintenance access in front of equipment.
 22. Indicate dimensions of fully-open access doors.
- D. Coordination Drawings for Cable Tray Routing: Reflected ceiling plan(s), supplemented by sections and other details, drawn to scale, in accordance with Section 01 31 00 "Project Management and Coordination," on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Elevation, size, and route of cable trays.
 2. Relationships between components and adjacent structural, electrical, and mechanical elements.
 3. Vertical and horizontal offsets and transitions.
 4. Elevation and size of sleeves for wall, ceiling, and floor cable penetrations.
 5. Elevation of ceilings and size of ceiling tiles.
 6. Locations of access panels on ceilings.
 7. Locations where cable tray crosses or parallels sprinkler piping.
 8. Locations where cable tray crosses plumbing piping.
 9. Locations where cable tray crosses or parallels ductwork.
 10. Locations of access panels on ductwork.
 11. Locations where cable tray crosses conduit.
 12. Items blocking access around cable trays, including the following:
 - a. Light fixtures.
 - b. Speakers.
 - c. Fire-alarm devices.
 - d. Power outlets.
 - e. Wall-mounted equipment.
 - f. Equipment racks.
 - g. Furniture.
 - h. Door swings.
 - i. Building features.

13. Indicate clear dimension between cable tray and walls or obstructions that are closer than 10 ft.
 14. Highlight locations where cable tray is greater than 3 ft above ceilings. Explain how personnel access will be accommodated for cable tray maintenance.
- E. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- F. Coordination Drawings for Large Equipment Indoor Installations:
1. Location plan, drawn to scale, showing heavy equipment or truck access paths to loading dock or other freight access into building. Indicate available width and height of doors or openings.
 2. Floor plan for entry floor and floor where equipment is located, drawn to scale, showing heavy equipment access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Dimensioned concrete bases, outlines of equipment, conduit entries, and grounding equipment locations.
 - b. If freight elevator must be used, indicate width and height of door and depth of car. Indicate if large equipment must be tipped to use elevator.
 - c. Dimensioned working clearances and dedicated areas below and around electrical equipment where obstructions and tripping hazards are prohibited.
 3. Reflected ceiling plans for entry floor and floor where equipment is located, drawn to scale, on which the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways[, **busways,**] [**and seismic bracing**].
 - b. Location of lighting fixtures, sprinkler piping and sprinklers, ducts and diffusers, and other obstructions, indicating available overhead clearance.
 - c. Dimensioned working clearances and dedicated areas above and around electrical equipment where foreign systems and equipment are prohibited.
- G. Coordination Drawings for Large Equipment Outdoor Installations:
1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:
 - a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
 - b. Indicate clear dimensions for fence gates and wall openings.
 - c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
 - d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.

- e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways[, **busways,**] [**and seismic bracing**].
- f. Dimensioned working clearances and dedicated areas around electrical equipment.

H. Coordination Drawings for Duct Banks:

1. Show duct profiles and coordination with other utilities and underground structures.
2. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

3.3 INSTALLATION OF ELECTRICAL WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

3.4 FIELD QUALITY CONTROL

A. Administrant for Low-Voltage Electrical Tests and Inspections:

1. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Administrant for Field Tests and Inspections of Lighting Installations:

1. Administer and perform tests and inspections with assistance of factory-authorized service representative.

3.5 CLOSEOUT ACTIVITIES

A. Operation and Maintenance Data: Prepare and submit the following:

1. Provide emergency operation, normal operation, and preventive maintenance manuals for each system, equipment, and device.
2. Include the following information:
 - a. Manufacturer's operating specifications.
 - b. User's guides for software and hardware.
 - c. Schedule of maintenance material items recommended to be stored at Project site.
 - d. Detailed instructions covering operation under both normal and abnormal conditions.
 - e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
 - f. List of load-current and overload-relay heaters with related motor nameplate data.
 - g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.
 - h. Manufacturer's instructions for setting field-adjustable components.
 - i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
 - j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
 - k. Include copies of demonstration and training videos.

- B. Software and Firmware Operational Documentation: Provide software and firmware operational documentation, including the following:
1. Software operating and upgrade manuals.
 2. Names, versions, and website addresses for locations of installed software.
 3. Device address list.
 4. Printout of software application and graphic screens.
 5. Testing and adjusting of panic and emergency power features.
 6. For lighting controls, include the following:
 - a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
 - b. Operation of adjustable zone controls.
 - c. As-Built documentation indicating final lighting zones and settings. As-built documentation shall be additionally updated after 30 days of occupancy with any owner requested changes.
- C. Software:
1. Program Software Backup: Provide username and password for approved online or cloud solution.
 2. Provide to Owner upgrades and unrestricted licenses for installed and backup software, including operating systems and programming tools required for operation and maintenance.
- D. Demonstration: With assistance from factory-authorized service representatives, demonstrate to Owner's maintenance and clerical personnel how to operate the following systems and equipment:
1. Lighting control system and devices.
- E. Training: With assistance from factory-authorized service representatives, train Owner's maintenance personnel on the following topics:
1. Preventative maintenance for all systems.
 2. Electrical power safety fundamentals refresher including arc-flash hazard safety features of electrical power distribution equipment in facility, interpreting arc-flash warning labels, selecting appropriate personal protective equipment, and understanding significance of findings documented in study report specified in Section 26 05 73.19 "Arc-Flash Hazard Analysis."
 3. How to adjust, operate, and maintain devices specified in Section 26 09 23 "Lighting Control Devices."

END OF SECTION 26 00 10

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Aluminum building wire.
3. Metal-clad cable, Type MC.
4. Fire-alarm wire and cable.
5. Connectors and splices.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Copper building wire.
2. Metal-clad cable, Type MC.
3. Armored cable, Type AC.
4. Tray cable, Type TC.
5. Fire-alarm wire and cable.
6. Connectors and splices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Alpha Wire; brand of Belden, Inc.](#)
2. [General Cable; Prysmian Group North America.](#)
3. [Okonite Company \(The\).](#)
4. [Southwire Company, LLC.](#)

B. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

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: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:
1. Type NM. Comply with UL 83 and UL 719.
 2. Type TC-ER. Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 3. Type THHN and Type THWN-2. Comply with UL 83.
 4. Type XHHW-2. Comply with UL 44.
- F. Shield:
1. Type TC-ER: Cable designed for use with ASDs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.
- 2.2 METAL-CLAD CABLE, TYPE MC
- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [AFC Cable Systems; Atkore International.](#)
 2. [Alpha Wire; brand of Belden, Inc.](#)
 3. [General Cable; Prysmian Group North America.](#)
 4. [Okonite Company \(The\).](#)
 5. [Southwire Company, LLC.](#)
- B. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- 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 multicircuit with color-coded conductors.
 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- F. Ground Conductor: Insulated.

- G. Conductor Insulation:
1. Type TFN/THHN/THWN-2. Comply with UL 83.
 2. Type XHHW-2. Comply with UL 44.

H. Armor: Steel, interlocked.

I. Jacket: PVC applied over armor.

2.3 FIRE-ALARM WIRE AND CABLE

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

1. [Allied Wire & Cable Inc.](#)
2. [PYROTENAX; brand of nVent Electrical plc.](#)
3. [Prysmian Cables and Systems; Prysmian Group North America.](#)
4. [West Penn Wire; brand of Belden, Inc.](#)

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 14 AWG.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 14 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

2.4 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [3M Electrical Products.](#)
2. [AFC Cable Systems; Atkore International.](#)
3. [Ideal Industries, Inc.](#)
4. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
5. [TE Connectivity Ltd.](#)

B. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: One hole with standard barrels.
 - 3. Termination: Mechanical.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 - 1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - 2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits:
 - 1. Copper:
 - a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
 - b. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type XHHW-2, single conductors in raceway Metal-clad cable, Type MC.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway Metal-clad cable, Type MC.
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- F. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

- B. Complete raceway installation between conductor and cable termination points in accordance with Section 26 05 33.13 "Conduits for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 27 05 28.29 "Hangers and Supports for Communications Systems."
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
 - 4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

- F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.
- G. Wiring to Remote Alarm Transmitting Device: 1 inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.
- D. Comply with requirements in Section 28 46 21.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "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.

3.7 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 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors and conductors.
 - 3. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:

- 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
- c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cable hardware.
6. Twin-axial data highway cable.
7. RS-232 cable.
8. RS-485 cable.
9. Control cable.
10. Control-circuit conductors.
11. Fire-alarm wire and cable.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cable hardware.
6. Twin-axial data highway cable.
7. RS-232 cable.
8. RS-485 cable.
9. Control cable.
10. Control-circuit conductors.
11. Fire-alarm wire and cable.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE 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. 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.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. 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.

2.2 BACKBOARDS

- A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inch. Comply with requirements for plywood backing panels in Section 06 10 00 "Rough Carpentry."
- B. Painting: Paint plywood on all sides and edges with eggshell White fire resistant paint. Comply with requirements in Section 09 91 23 "Interior Painting."

2.3 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. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Belden Inc.](#)
 - 2. [Berk-Tek, a Leviton Company.](#)
 - 3. [CommScope, Inc.](#)
 - 4. [General Cable; Prysmian Group North America.](#)
 - 5. [West Penn Wire; brand of Belden, Inc.](#)
- C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.
- D. Conductors: 100 ohm, No. 24 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP).
- F. Cable Rating: Plenum.
- G. Jacket: Black, or as Indicated by RIC in the submittal process, thermoplastic.

2.4 CATEGORY 6 BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. [Belden Inc.](#)
 - 2. [Berk-Tek, a Leviton Company.](#)
 - 3. [CommScope, Inc.](#)
 - 4. [General Cable; Prysmian Group North America.](#)
 - 5. [Prysmian Cables and Systems; Prysmian Group North America.](#)
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- D. Conductors: 100 ohm, No. 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP).
- F. Cable Rating: Plenum.
- G. Jacket: Black, or as Indicated by RIC in the submittal process, thermoplastic.

2.5 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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Belden Inc.](#)
 - 2. [Berk-Tek, a Leviton Company.](#)
 - 3. [CommScope, Inc.](#)
 - 4. [General Cable; Prysmian Group North America.](#)
 - 5. [Prysmian Cables and Systems; Prysmian Group North America.](#)
- C. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- D. Conductors: 100 ohm, No. 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP).
- F. Cable Rating: Plenum.
- G. Jacket: Black, or as Indicated by RIC in the submittal process, thermoplastic.

2.6 BALANCED TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

- B. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Belden Inc.](#)
 2. [Berk-Tek, a Leviton Company.](#)
 3. [CommScope, Inc.](#)
 4. [General Cable; Prysmian Group North America.](#)
 5. [Leviton Manufacturing Co., Inc.](#)
- C. General Requirements for Balanced Twisted Pair Cable Hardware:
1. Comply with the performance requirements of Category 6a.
 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.
- D. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.
- E. Connecting Blocks: 110-style IDC for Category 5e 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.
- G. 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. Replaceable connectors.
 - d. 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.
- H. Patch Cords: Factory-made, four-pair cables in 48 inch lengths; 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.
 2. Patch cords must have color-coded boots for circuit identification.
- I. 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.

J. 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 5e, shielded balanced twisted pair cable must comply with IEC 60603-7-3.
 - c. Category 6, unshielded balanced twisted pair cable must comply with IEC 60603-7-4.
 - d. Category 6, shielded balanced twisted pair cable must comply with IEC 60603-7-5.
 - e. Category 6a, unshielded balanced twisted pair cable must comply with IEC 60603-7-41.
 - f. Category 6a, shielded balanced twisted pair cable must comply with IEC 60603-7.51.
4. Marked to indicate transmission performance.

K. Faceplate:

1. Two port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 05 33.16 "Boxes and Covers for Electrical Systems."
3. Metal Faceplate: Stainless steel, complying with requirements in Section 26 05 33.16 "Boxes and Covers for Electrical Systems."
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.

L. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 RS-232 CABLE

A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Allied Wire & Cable Inc.](#)
2. [Belden Inc.](#)
3. [General Cable; Prysmian Group North America.](#)
4. [Southwire Company, LLC.](#)

B. PVC-Jacketed, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. [<Double click to insert sustainable design text for lead content.>](#)
3. Polypropylene insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. PVC jacket.
6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

7. NFPA 70 Type: Type CM.
8. Flame Resistance: Comply with UL 1581.

C. Plenum-Type, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. [<Double click to insert sustainable design text for lead content.>](#)
3. PE insulation.
4. Aluminum foil-polyester tape shield with 100 percent shield coverage.
5. Fluorinated ethylene propylene jacket.
6. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
7. Flame Resistance: Comply with NFPA 262.

2.8 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, one pair, 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.

2.9 CONTROL CABLE

A. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.10 CONTROL-CIRCUIT CONDUCTORS

A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [General Cable: Prysmian Group North America.](#)
2. [Southwire Company, LLC.](#)

B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

2.11 FIRE-ALARM WIRE AND CABLE

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Allied Wire & Cable Inc.](#)
 2. [CommScope, Inc.](#)
 3. [Prysmian Cables and Systems: Prysmian Group North America.](#)
 4. [West Penn Wire; brand of Belden, Inc.](#)
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 16 AWG.
1. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.

2.12 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test cables on receipt at Project site.
1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 26 05 33.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or modified in this Section.
- B. Comply with requirements in Section 26 05 33.23 "Surface Raceways for Electrical Systems" for raceway selection and installation requirements for wireways as supplemented or modified in this Section.
- C. Comply with requirements in Section 26 05 33.16 "Boxes and Covers for Electrical Systems" for raceway selection and installation requirements for boxes as supplemented or modified in this Section.
1. Outlet boxes must be no smaller than 2 inch wide, 3 inch high, and 2-1/2 inch deep.
 2. Outlet boxes for cables must be no smaller than 4 inch square by 1-1/2 inch deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.

3. Flexible metal conduit must not be used.
- D. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
 - E. Install manufactured conduit sweeps and long-radius elbows if possible.
 - F. 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.
 - G. Backboards: Install backboards with 96 inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 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, and 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.
 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 dereeling. 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. Demonstrate ground resistance.
- C. Balanced Twisted Pair Cable Installation:
1. Comply with TIA-568-C.2.
 2. Install termination hardware as specified in Section 27 15 13 "Communications Copper Horizontal Cabling" unless otherwise indicated.
 3. Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.
- D. Installation of Control-Circuit Conductors:
1. Install wiring in raceways.
 2. Use insulated spade lugs for wire and cable connection to screw terminals.
- E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend copper cable not in a wireway or pathway a minimum of 8 inch above ceilings by cable supports not more than 30 inch apart.
 3. 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.
- F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Below each feed point, neatly coil a minimum of 72 inch of cable in a coil not less than 12 inch in diameter.
- G. 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.

3.4 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.

3.5 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.

3.6 FIRESTOPPING

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 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 05 26 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- 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.

3.9 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 26 05 23

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connector.
7. Grounding and bonding busbars.
8. Signal reference grids.
9. Grounding (earthing) electrodes.
10. Grounding electrode enclosures.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 27 05 28 "Pathways for Communications Systems" specifies additional requirements for grounding and bonding of communications raceways, boxes, and cable trays.
3. Section 27 11 00 "Communications Equipment Room Fittings" specifies additional requirements for grounding and bonding of communications equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control for Grounding and Bonding of Electrical Power" Article, including the following:

1. Grounding electrode access enclosures.
2. Grounding electrodes.
3. Grounding arrangements and connections for separately derived systems.

C. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in Section 26 00 10 "Supplemental Requirements for Electrical," include the following:
 - a. Plans showing locations of grounding features described in "Field Quality Control for Grounding and Bonding of Electrical Power" Article, including the following:

- 1) Grounding electrode access enclosures.
- 2) Grounding electrodes.
- 3) Grounding arrangements and connections for separately derived systems.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper or tinned-copper wire or cable, green color, in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Isolated Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper or tinned-copper wire or cable, green color with one or more yellow stripes, in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. ASTM - Bare Copper Grounding and Bonding Conductor:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ERICO; brand of nVent Electrical plc.](#)
 - b. [Harger Lightning & Grounding; business of Harger, Inc.](#)
2. Referenced Standards: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3.
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

D. UL KDER - Armored Grounding Wire:

1. Description: Single corrosion-resistant copper, aluminum, or copper-clad aluminum conductor within helically formed steel armor.
2. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [LS Cable & System USA; subsidiary of LS Corp.](#)
 - b. [Southwire Company, LLC.](#)
3. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
4. Listing Criteria:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- E. UL KDSH - Protector Grounding Conductor:
- 1. Description: Conductors intended to be used for grounding primary protector or metallic members of cable sheath in accordance with Chapters 7 and 8 of NFPA 70.
 - 2. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Superior Essex Inc.; subsidiary of LS Corp.](#)
 - 3. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 4. Listing Criteria:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 - 5. Options:
 - a. Color: green.
- 2.2 GROUNDING AND BONDING CLAMPS
- A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.
 - B. Source Limitations: Obtain products from single manufacturer.
 - C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 - D. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Arlington Industries, Inc.](#)
 - b. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - c. [ERICO; brand of nVent Electrical plc.](#)
 - d. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
2. General Characteristics:
- a. Two pieces with stainless steel bolts.
 - b. Clamp Material: Brass.
 - c. Listed for outdoor use.
- E. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Arlington Industries, Inc.](#)
 - b. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - c. [ERICO; brand of nVent Electrical plc.](#)
 - d. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 2. General Characteristics:
 - a. Clamp Material: Brass.
 - b. Listed for outdoor use.
- F. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Burdny; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - b. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - c. [ERICO; brand of nVent Electrical plc.](#)
 - d. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 2. General Characteristics:
 - a. Clamp Material: Copper.
 - b. Listed for outdoor use.
- G. UL KDER - Exothermically Welded Connection:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.](#)
 - b. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - c. [ERICO; brand of nVent Electrical plc.](#)
 - d. [Harger Lightning & Grounding; business of Harger, Inc.](#)
 2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- D. UL KDER - Bonding Bushing:
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Arlington Industries, Inc.](#)
 - b. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - c. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - d. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - 2. General Characteristics: Threaded bushing with insulated throat.
- E. UL KDER - Grounding Bushing:
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Arlington Industries, Inc.](#)
 - b. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - c. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - d. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - 2. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.4 GROUNDING AND BONDING HUBS

- A. Description: Hubs with certified grounding or bonding locknut.
- B. Source Limitations: Obtain products from single manufacturer.

- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- D. UL KDER - Grounding and Bonding Hub:
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Arlington Industries, Inc.](#)
 - b. [Burdny; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - c. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - d. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - 2. General Characteristics: Insulated, gasketed, watertight hub with mechanical-type wire terminal.

2.5 GROUNDING AND BONDING CONNECTORS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- C. UL KDER - Pressure-Type Grounding and Bonding Busbar Cable Connector:
 - 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Burdny; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - 2. General Characteristics: Copper or copper alloy, for compression bonding of one or more conductor directly to copper busbar. Listed for direct burial.

- D. UL KDER - Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ABB, Electrification Business.
 - b. Chatsworth Products, Inc.
 - c. Greaves Corp.; Essex Products Group, Inc.
 - d. ILSCO.
 2. General Characteristics: Mechanical-type, copper rated for direct burial terminal with set screw.
- E. UL KDER - Crimped Lug Pressure-Type Grounding and Bonding Busbar Terminal:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ABB, Electrification Business.
 - b. Harger Lightning & Grounding; business of Harger, Inc.
 - c. ILSCO.
 2. General Characteristics: Cast silicon bronze, solderless compression-type wire terminals; with long barrel and two holes spaced on 5/8 or 1 inch centers for two-bolt connection to busbar.
- F. UL KDER - Split-Bolt Service-Post Pressure-Type Grounding and Bonding Busbar Terminal:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Panduit Corp.
 2. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened after assembly is screwed into busbar opening.
- G. UL KDER - Crimped Pressure-Type Grounding and Bonding Cable Connector:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. ILSCO.
 2. General Characteristics: Crimp-and-compress connectors that bond to conductor when connector is compressed around conductor.
 - a. Copper, C and H shaped.
- H. UL KDER - Split-Bolt Pressure-Type Grounding and Bonding Cable Connector:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [ERICO; brand of nVent Electrical plc.](#)
 - b. [Greaves Corp.; Essex Products Group, Inc.](#)
 2. General Characteristics: Bolts that surround cable and bond to cable under compression when nut is tightened.
 - a. Copper.
 - I. UL KDER - Signal Reference Grid Grounding and Bonding Connector:
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - b. [ERICO; brand of nVent Electrical plc.](#)
 - c. [Harger Lightning & Grounding; business of Harger, Inc.](#)
 2. General Characteristics: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.
- 2.6 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS
 - A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.
 - B. Performance Criteria:
 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Listing Criteria:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
 - C. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector:
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Galvan Industries, Inc.; Electrical Products Division, LLC.](#)
 - b. [Madison Electric Products; business of Southwire Company, LLC.](#)
 2. General Characteristics: Zinc-alloy one-piece construction; six terminating points; gangable.
 - D. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector:
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
- b. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
- c. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)

2. General Characteristics: Copper body and polycarbonate cover; four terminating points.

2.7 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding devices that serve as common connection for multiple grounding and bonding conductors.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

3. Sustainability Characteristics:

- a. [Lead Content](#): Less than 300 parts per million.

D. UL KDER - Equipment Room Grounding and Bonding Busbar:

1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
- b. [ERICO; brand of nVent Electrical plc.](#)
- c. [Harger Lightning & Grounding; business of Harger, Inc.](#)
- d. [Hoffman; brand of nVent Electrical plc.](#)
- e. [ILSCO.](#)
- f. [Panduit Corp.](#)

2. General Characteristics:

- a. Bus: Rectangular bar of annealed copper.
- b. Mounting Stand-Off Insulators: Lexan or PVC.

1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

3. Options:

- a. Dimensions: 1/4 by 4 inch in cross section; 12" minimum length.
- b. Predrilled Hole Pattern: Complying with BICSI N3 and TIA-607.

- c. Mounting Hardware: Stand-off brackets that provide 2 inch clearance to access rear of bus. Brackets and bolts must be stainless steel.
- E. UL KDER - Rack and Cabinet Bonding Busbar:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - b. [Harger Lightning & Grounding; business of Harger, Inc.](#)
 - c. [Hoffman; brand of nVent Electrical plc.](#)
 - d. [Panduit Corp.](#)
 2. General Characteristics:
 - a. Bus: Rectangular bar of hard-drawn solid copper.
 - b. Horizontal Mounting Dimensions: Designed for mounting in equipment racks or cabinets per approved equipment shop drawings.
 - c. Vertical Mounting Dimensions: Designed for mounting in equipment racks or cabinets per approved equipment shop drawings.
 - d. Predrilled Hole Pattern: Accepts connectors for grounding and bonding conductor sizes 14 AWG to 2/0 AWG.
 - e. Mounting Hardware: Stainless steel or copper-plated, for attachment to rack.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

- A. Grounding and Bonding Conductors:
 1. Provide solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
 2. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
 3. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.
 4. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
7. Underground Grounding Conductors: Install barecopper conductor, 2/0 AWG minimum.

B. Grounding and Bonding Connectors:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

C. Grounding and Bonding Busbars: Provide in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on Drawings.

3.3 SELECTION OF GROUNDING AND BONDING PRODUCTS FOR COMMUNICATIONS

- A. Comply with Section 27 05 28 "Pathways for Communications Systems" and Section 27 11 00 "Communications Equipment Room Fittings."

3.4 INSTALLATION OF GROUNDING AND BONDING

- A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:
 - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

- e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - g. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
3. Grounding and Bonding Busbars:
- a. Install busbar horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
 - b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.
4. Equipment Grounding and Bonding:
- a. Install insulated equipment grounding conductors with feeders and branch circuits.
 - b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Single-phase motor and appliance branch circuits.
 - 5) Three-phase motor and appliance branch circuits.
 - 6) Flexible raceway runs.
 - 7) Armored and metal-clad cable runs.
 - 8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
 - d. Isolated Grounding Receptacle Circuits: Install insulated equipment grounding conductor connected to receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.
 - e. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at

equipment grounding conductor terminal of applicable derived system or service unless otherwise indicated.

3.5 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.

B. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

C. Collect, assemble, and submit test and inspection reports.

1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System: 10 Ω .
 - b. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 Ω .

3.6 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Support, anchorage, and attachment components.
2. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.

- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Allied Tube & Conduit; Atkore International.](#)
 - b. [CADDY; brand of nVent Electrical plc.](#)
 - c. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - d. [Unistrut; Atkore International.](#)
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 4. Channel Width: Selected for applicable load criteria.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Flex-Strut Inc.](#)
 - b. [Haydon Corporation.](#)
 - c. [MKT Metal Manufacturing.](#)
 - d. [Unistrut; Atkore International.](#)
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Material: 6063-T5 aluminum alloy.
 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 5. Channel Width: Selected for applicable load criteria.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center, in at least one surface.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Allied Tube & Conduit; Atkore International.](#)
 - b. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - c. [G-Strut.](#)
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Width: Selected for applicable load criteria.
 4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 5. Fitting and Accessory Materials: Same as those for channels and angles.
 6. Rated Strength: Selected to suit applicable load criteria.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) [Hilti, Inc.](#)
 - 2) [ITW Ramset/Red Head; Illinois Tool Works, Inc.](#)
 - 3) [MKT Fastening, LLC.](#)
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - 2) [Hilti, Inc.](#)
 - 3) [ITW Ramset/Red Head; Illinois Tool Works, Inc.](#)

4) [MKT Fastening, LLC.](#)

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: All steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA NEIS 101
 2. NECA NEIS 102.
 3. NECA NEIS 105.
 4. NECA NEIS 111.
- B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERM as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT IMC and ERMCM may be supported by openings through structure members, in accordance with NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.4 PAINTING

- A. Touchup:
 - 1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

2. Comply with requirements in Section 09 91 23 "Interior Painting" and Section 09 96 00 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Type EMT-A and Type EMT-SS raceways and elbows.
2. Type EMT-S raceways and elbows.
3. Type ENT raceways and fittings.
4. Type EPEC raceways and fittings.
5. Type ERMC-A and Type ERMC-SS raceways, elbows, couplings, and nipples.
6. Type ERMC-S raceways, elbows, couplings, and nipples.
7. Type FMC-S and Type FMC-A raceways.
8. Type FMT raceways.
9. Type IMC raceways.
10. Type LFMC raceways.
11. Type LFNC raceways.
12. Type PVC raceways and fittings.
13. Type RTRC-AG raceways and fittings.
14. Type RTRC-BG raceways and fittings.
15. Fittings for conduit, tubing, and cable.
16. Threaded metal joint compound.
17. Solvent cements.
18. Surface metal raceways and fittings.
19. Surface nonmetallic raceways.
20. Strut-type channel raceways and fittings.
21. Wireways and auxiliary gutters.
22. Metallic outlet boxes, device boxes, rings, and covers.
23. Nonmetallic outlet boxes, device boxes, rings, and covers.
24. Termination boxes.
25. Cabinets, cutout boxes, junction boxes, pull boxes, and miscellaneous enclosures.
26. Cover plates for device boxes.
27. Hoods for outlet boxes.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 05 19 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
3. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
4. Section 27 05 28 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
5. Section 27 05 43 "Underground Pathways and Structures for Communication Systems" for exterior communications duct banks, manholes, and underground utility construction.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.
2. Surface metal raceways.
3. Surface nonmetallic raceways.
4. Floor boxes.
5. Cabinets, cutout boxes, and miscellaneous enclosures.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details. Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness at location where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions:

1. For Type ERM-C-S-PVC.

PART 2 - PRODUCTS

2.1 TYPE EMT-S RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 797 and UL Category Control Number FJMX.

B. Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Allied Tube & Conduit; Atkore International.](#)
 - b. [Western Tube; Zekelman Industries.](#)
 - c. [Wheatland Tube; Zekelman Industries.](#)
2. Material: Steel.
3. Options:
 - a. Exterior Coating: Zinc.
 - b. Interior Coating: Zinc with organic top coating.
 - c. Minimum Trade Size: 3/4".
 - d. Colors: As indicated on Drawings.

2.2 TYPE ERM-C-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 6 and UL Category Control Number DYIX.
- B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Allied Tube & Conduit; Atkore International.](#)
 - b. [Western Tube; Zekelman Industries.](#)
 - c. [Wheatland Tube; Zekelman Industries.](#)
 2. Exterior Coating: Zinc.
 3. Options:
 - a. Interior Coating: Zinc with organic top coating.
 - b. Minimum Trade Size: 3/4".
 - c. Colors: As indicated on Drawings.
- 2.3 TYPE FMC-S AND TYPE FMC-A RACEWAYS
- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 1 and UL Category Control Number DXUZ.
- B. Steel Flexible Metal Conduit (FMC-S):
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [International Metal Hose Co.](#)
 - c. [Topaz Lighting & Electric.](#)
 2. Material: Steel.
 3. Options:
 - a. Minimum Trade Size: 3/4".
 - b. Colors: As indicated on Drawings.
- 2.4 TYPE IMC RACEWAYS
- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 1242 and UL Category Control Number DYBY.
- B. Steel Electrical Intermediate Metal Conduit (IMC):

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Allied Tube & Conduit; Atkore International.](#)
 - c. [Western Tube; Zekelman Industries.](#)
 - d. [Wheatland Tube; Zekelman Industries.](#)
2. Options:
 - a. Exterior Coating: Zinc.
 - b. Interior Coating: Zinc with organic top coating.
 - c. Minimum Trade Size: 3/4".
 - d. Colors: As indicated on Drawings.

2.5 TYPE LFMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 360 and UL Category Control Number DXHR.

B. Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Electri-Flex Company.](#)
 - c. [International Metal Hose Co.](#)
2. Material: Steel.
3. Options:
 - a. Minimum Trade Size: 3/4".
 - b. Colors: As indicated on Drawings.

C. Stainless Steel Liquidtight Flexible Metal Conduit (LFMC-SS):

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Electri-Flex Company.](#)
 - c. [International Metal Hose Co.](#)
2. Material: Stainless steel.
3. Options:
 - a. Minimum Trade Size: 3/4".
 - b. Colors: As indicated on Drawings.

2.6 TYPE LFNC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1660 and UL Category Control Number DXOQ.

B. Layered (Type A) Liquidtight Flexible Nonmetallic Conduit (LFNC-A):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [AFC Cable Systems; Atkore International.](#)
 - b. [Electri-Flex Company.](#)
2. Additional Criteria: Type A conduit with smooth seamless inner core and cover bonded together with one or more reinforcement layers between core and cover.
3. Options:
 - a. Minimum Trade Size: 3/4".
 - b. Colors: As indicated on Drawings.
 - c. Markings: 90 deg C dry Sunlight resistant Outdoor.

C. Integral (Type B) Liquidtight Flexible Nonmetallic Conduit (LFNC-B):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [AFC Cable Systems; Atkore International.](#)
 - b. [Electri-Flex Company.](#)
2. Additional Criteria: Type B conduit with smooth inner surface with integral reinforcement within conduit wall.
3. Options:
 - a. Minimum Trade Size: 3/4".
 - b. Colors: As indicated on Drawings.
 - c. Markings: 90 deg C dry Sunlight resistant Outdoor.

2.7 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL Category Control Number DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [ABB, Electrification Business.](#)
 - b. [Calconduit; Atkore International.](#)
 - c. [Opti-Com Manufacturing Network, Inc \(OMNI\).](#)
2. Dimensional Specifications: Schedule 40.
 3. Options:
 - a. Minimum Trade Size: 3/4".
 - b. Markings: For use with maximum 90 deg C wire.
- C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Calconduit; Atkore International.](#)
 - c. [Opti-Com Manufacturing Network, Inc \(OMNI\).](#)
 2. Dimensional Specifications: Schedule 80.
 3. Options:
 - a. Minimum Trade Size: 3/4".
 - b. Markings: For use with maximum 90 deg C wire.

2.8 FITTINGS FOR CONDUIT, TUBING, AND CABLE

- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- B. Fittings for Type ERM, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Appleton; Emerson Electric Co., Automation Solutions.](#)
 - c. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - d. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - e. [Southwire Company, LLC.](#)
 2. General Characteristics: UL 514B and UL Category Control Number DWTT.
 3. Options:
 - a. Material: Steel.
 - b. Coupling Method: Compression coupling or Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
 - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

- C. Fittings for Type EMT Raceways:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ABB, Electrification Business.
 - b. Allied Tube & Conduit; Atkore International.
 - c. Appleton; Emerson Electric Co., Automation Solutions.
 - d. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 - f. Southwire Company, LLC.
 2. General Characteristics: UL 514B and UL Category Control Number FKAV.
 3. Options:
 - a. Material: Steel.
 - b. Coupling Method: Compression coupling or Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
 - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.
- D. Fittings for Type FMC Raceways:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Fittings Corp. (AMFICO).
 - b. Liquid Tight Connector Co.
 - c. Southwire Company, LLC.
 2. General Characteristics: UL 514B and UL Category Control Number ILNR.
- E. Fittings for Type LFMC and Type LFNC Raceways:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Arlington Industries, Inc.
 - b. Liquid Tight Connector Co.
 2. General Characteristics: UL 514B and UL Category Control Number DXAS.
- 2.9 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT
- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 2419 and UL Category Control Number FOIZ.
 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ABB, Electrification Business.

2.10 SOLVENT CEMENTS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL Category Control Number DWTT.
3. Sustainability Characteristics:

2.11 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 514A and UL Category Control Number QCIT.

B. Metallic Outlet Boxes:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Appleton; Emerson Electric Co., Automation Solutions.
 - b. Arlington Industries, Inc.
 - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - d. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
3. Options:
 - a. Material: Sheet steel or Cast metal.
 - b. Sheet Metal Depth: Minimum **1.5 inch**.
 - c. Cast-Metal Depth: Minimum **1.8 inch**.
 - d. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to **50 lb**.

C. Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Appleton; Emerson Electric Co., Automation Solutions.
 - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 - e. Pass & Seymour; Legrand North America, LLC.

- f. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)

D. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.
2. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Appleton; Emerson Electric Co., Automation Solutions.](#)
 - b. [Arlington Industries, Inc.](#)
 - c. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - d. [Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - e. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - f. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
3. Options:
 - a. Material: Sheet steel or Cast metal.
 - b. Sheet Metal Depth: minimum **1.5 inch**.
 - c. Cast-Metal Depth: minimum **1.8 inch**.

E. Metallic Extension Rings:

1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
2. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Appleton; Emerson Electric Co., Automation Solutions.](#)
 - b. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - c. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - d. [Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - e. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - f. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)

F. Metallic Floor Boxes and Floor Box Covers:

1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
2. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Appleton; Emerson Electric Co., Automation Solutions.](#)
 - b. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - c. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - d. [Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - e. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - f. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)

2.12 JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Non-Environmental Characteristics: UL 50.
 - b. Environmental Characteristics: UL 50E.

B. Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Appleton; Emerson Electric Co., Automation Solutions.](#)
 - b. [Cooper B-line; brand of Eaton, Electrical Sector.](#)
 - c. [Hoffman; brand of nVent Electrical plc.](#)
 - d. [Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - e. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - f. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - g. [Square D; Schneider Electric USA.](#)
3. Options:
 - a. Degree of Protection: Type 1.

C. Indoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Appleton; Emerson Electric Co., Automation Solutions.](#)
 - b. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - c. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
3. Options:
 - a. Degree of Protection: Type 1.

D. Indoor Polymeric Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Allied Tube & Conduit; Atkore International.](#)

- b. [Cantex Inc.](#)
 - c. [Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 3. Options:
 - a. Degree of Protection: Type 1.
- 2.13 COVER PLATES FOR DEVICES BOXES
- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics:
 - a. Wallplate-Securing Screws: Metal with head color to match wallplate finish.
 - B. Metallic Cover Plates for Device Boxes:
 1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Appleton; Emerson Electric Co., Automation Solutions.](#)
 - b. [Arrow Hart, Wiring Devices; Eaton, Electrical Sector.](#)
 - c. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - d. [Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - e. [Leviton Manufacturing Co., Inc.](#)
 - f. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - g. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - h. [Wiremold; Legrand North America, LLC.](#)
 2. Options:
 - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - b. Wallplate Material: As indicated on architectural Drawings.

2.14 HOODS FOR OUTLET BOXES

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics:
 - a. Reference Standards:
 - 1) UL 514D and UL Category Control Numbers QCIT and QCMZ.
 - 2) Receptacle, hood, cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.

- b. Mounts to box using fasteners different from wiring device.
- B. Extra-Duty, While-in-Use Hoods for Outlet Boxes:
- 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
 - 2. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.
 - 3. Options:
 - a. Provides clear, weatherproof, "while-in-use" cover.
 - b. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 - EXECUTION

3.1 SELECTION OF RACEWAYS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.
- B. Outdoors:
- 1. Exposed and Subject to Severe Physical Damage: ERMCM or IMC.
 - 2. Exposed and Subject to Physical Damage: ERMCM or IMC.
 - a. Locations less than 2.5 m (8 ft) above finished floor.
 - 3. Exposed and Not Subject to Physical Damage: ERMCM, IMC, or Corrosion-resistant EMT.
 - 4. Concealed Aboveground: ERMCM, IMC, EMT, PVC-80, or PVC-40.
 - 5. Concrete Encased Not in Trench: PVC-80, or PVC-40.
 - 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- C. Indoors:
- 1. Exposed and Subject to Severe Physical Damage: ERMCM or IMC. Subject to severe physical damage includes the following locations:
 - a. Mechanical rooms.
 - 2. Exposed and Subject to Physical Damage: ERMCM, IMC, or EMT. Subject to physical damage includes the following locations:
 - a. Locations less than 2.5 m (8 ft) above finished floor.
 - b. Stub-ups to above suspended ceilings.
 - 3. Exposed and Not Subject to Physical Damage: ERMCM, IMC, or EMT.

4. Concealed in Ceilings and Interior Walls and Partitions: ERM, IMC, or EMT.
5. Damp or Wet Locations: ERM, or IMC.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

D. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERM and IMC: Provide threaded type fittings unless otherwise indicated.

3.2 SELECTION OF BOXES AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

- a. Type 3R unless otherwise indicated.
- b. Locations Exposed to Hosedown: Type 4.
- c. Locations Subject to Potential Flooding: Type 6P.
- d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
- e. Locations in-Ground or Exposed to Corrosive Agents: Type 4X.
- f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

- a. Type 1 unless otherwise indicated.
- b. Damp or Dusty Locations: Type 12.

C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:

1. Boxes with knockouts or unprotected openings are prohibited.
2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.3 INSTALLATION OF RACEWAYS

A. Installation Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.
2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
3. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
4. Comply with NECA NEIS 101 for installation of steel raceways.
5. Comply with NECA NEIS 111 for installation of nonmetallic raceways.
6. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.

7. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts.
 8. Raceway Terminations at Locations Subject to Moisture or Vibration:
 - a. Provide insulating bushings to protect conductors, including conductors smaller than No. 4 AWG..
- B. General Requirements for Installation of Raceways:
1. Complete raceway installation before starting conductor installation.
 2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of **2 ft** above finished floor.
 3. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within **12 inch** of changes in direction.
 4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
 5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
 6. Support conduit within **12 inch** of enclosures to which attached.
 7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
 8. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:
 - a. Where conduits pass from warm to cold locations.
 - b. Conduit extending from interior to exterior of building.
 - c. Where otherwise required by NFPA 70.
 9. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.
 10. Do not install conduits within **2 inch** of the bottom side of a metal deck roof.
 11. Keep raceways at least **6 inch** away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
 12. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
 13. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than **200 lb** tensile strength. Leave at least **12 inch** of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- C. Requirements for Installation of Specific Raceway Types:
1. Types ERM and IMC:

- a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
2. Type ERM-C-S-PVC:
 - a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
 - b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERM-C-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERM-C-S-PVC raceway.
 - c. Coat field-cut threads on PVC-coated raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.
3. Types FMC, LFMC, and LFNC:
 - a. Comply with NEMA RV 3. Provide a maximum of **36 inch (915 mm)** of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
4. Types PVC and EPEC:
 - a. Do not install Type PVC or Type EPEC conduit where ambient temperature exceeds **122 deg F**. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
 - b. Comply with manufacturer's written instructions for solvent welding and fittings.
- D. Raceways Embedded in Slabs:
 1. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.
 2. Change from ENT to IMC before rising above floor.
- E. Stub-ups to Above Recessed Ceilings:
 1. Provide EMT, IMC, or ERM-C for raceways.
 2. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- F. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
 1. ERM-C-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 2. EMT: Provide setscrew, steel fittings. Comply with NEMA FB 2.10.
 3. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

3.4 INSTALLATION OF BOXES AND ENCLOSURES

- A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
- B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- C. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
- D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- E. Locate boxes so that cover or plate will not span different building finishes.
- F. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
- G. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
- H. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
- I. Set metal floor boxes level and flush with finished floor surface.
- J. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- K. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
- L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
- M. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - 1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - 2. Provide gaskets for wallplates and covers.

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.7 CLEANING

- A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION 26 05 33

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Type ERM-C raceways, elbows, couplings, and nipples.
2. Type IMC raceways.
3. Type PVC raceways and fittings.
4. Fittings for conduit, tubing, and cable.
5. Electrically conductive corrosion-resistant compounds for threaded conduit.
6. Solvent cements.
7. Duct accessories.
8. Handholes and boxes for exterior underground wiring.
9. Manholes for exterior underground wiring.
10. Duct sealing.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 05 53 "Identification for Electrical Systems" specifies underground-line warning tape and concrete cable routing markers.

1.2 DEFINITIONS

- A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.
- B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.
- C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.
- D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 ACTION SUBMITTALS

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

1. For concrete and steel used in precast concrete manholes and handholes, also include product certificates as required by ASTM C858.
 - B. Sustainable Design Product Data:
 1. [Product Data](#): For solvents and adhesives, indicating VOC content.
 2. Laboratory Test Reports: For solvents and adhesives, indicating compliance with requirements for low-emitting materials.
 - C. Shop Drawings:
 1. Electric Utility Duct Banks and Structures:
 - a. Include plans, elevations, sections, and details, including attachments to other Work.
 - b. Indicate locations of private property boundaries and utility easements.
 - c. Include information required for approval by electric utility and for obtaining public space utility work permits.
 2. Precast or Factory-Fabricated Concrete Structures:
 - a. Include plans, elevations, sections, and details, including attachments to other Work.
 - b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
 - c. Include reinforcement details.
 - d. Include frame and cover design and manhole chimneys.
 - e. Include ladder details.
 - f. Include grounding details.
 - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
 - h. Include joint details.
 3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.
 - D. Field quality-control reports.
- 1.4 INFORMATIONAL SUBMITTALS
- A. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

PART 2 - PRODUCTS

2.1 TYPE ERM-C-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 6 and UL CCN DYIX.

B. Galvanized-Steel Electrical Rigid Metal Conduit (ERM-C-S-G), Elbows, Couplings, and Nipples:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Allied Tube & Conduit; Atkore International.](#)
 - b. [Republic Conduit; Nucor Corporation, Nucor Tubular Products.](#)
 - c. [Wheatland Tube; Zekelman Industries.](#)
2. Exterior Coating: Zinc.
3. Options:
 - a. Interior Coating: Zinc with organic top coating].
 - b. Minimum Trade Size: Metric designator 27 (trade size 1).

2.2 TYPE IMC RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 1242 and UL CCN DYBY.

B. Steel Electrical Intermediate Metal Conduit (IMC):

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Allied Tube & Conduit; Atkore International.](#)
 - b. [Republic Conduit; Nucor Corporation, Nucor Tubular Products.](#)
 - c. [Wheatland Tube; Zekelman Industries.](#)
2. Options:
 - a. Exterior Coating: Zinc].
 - b. Interior Coating: Zinc with organic top coating].
 - c. Minimum Trade Size: Metric designator 27 (trade size 1).

2.3 TYPE PVC RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL 651 and UL CCN DZYR.

B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Calconduit; Atkore International.
 - b. Opti-Com Manufacturing Network, Inc (OMNI).
 - c. Topaz Lighting & Electric.
2. Dimensional Specifications: Schedule 40.
3. Options:
 - a. Minimum Trade Size: Metric designator 27 (trade size 1).
 - b. Markings: For use with maximum 90 deg C wire.

C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Calconduit; Atkore International.
 - b. Opti-Com Manufacturing Network, Inc (OMNI).
 - c. Topaz Lighting & Electric.
2. Dimensional Specifications: Schedule 80.
3. Options:
 - a. Minimum Trade Size: Metric designator 27 (trade size 1).
 - b. Markings: For use with maximum 90 deg C wire.

2.4 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

B. Metallic Fittings for Type ERM, Type IMC, and Type PVC Raceways:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Appleton; Emerson Electric Co., Automation Solutions.](#)
 - b. [Crouse-Hinds; brand of Eaton, Electrical Sector.](#)
 - c. [O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.](#)
 - d. [Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.](#)
2. General Characteristics: UL 514B and UL CCN DWTT.
 3. Options:
 - a. Material: Steel.
 - b. Coupling Method: Compression coupling, Raintight compression coupling with distinctive color gland nut or Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
 - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.
- 2.5 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT
- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.
 - B. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [ABB, Electrification Business.](#)
- 2.6 SOLVENT CEMENTS
- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.
 3. Sustainability Characteristics:
 - a. [VOC Content](#): 510 g/L or less for PVC conduit and fittings.
- 2.7 DUCT ACCESSORIES
- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Allied Tube & Conduit; Atkore International.](#)
- b. [Cantex Inc.](#)
- c. [Underground Devices, Inc.](#)

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. ASTM C858 for design and manufacturing processes.
 - b. SCTE 77.

B. Precast Concrete Handholes and Boxes:

1. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover must form top of enclosure and must have load rating consistent with that of handhole or box.
2. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Oldcastle Infrastructure Inc.; CRH Americas.](#)
 - b. [Utility Concrete Products, LLC.](#)
 - c. [Utility Vault Co.](#)
3. Configuration: Units must be designed for flush burial and have closed bottom unless otherwise indicated.
4. Frame and Cover:
 - a. Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - b. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - c. Cover Legend: Molded lettering, as indicated for each service.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension must provide increased depth of 12 inch.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
7. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch vertically and horizontally to accommodate alignment variations.
 - a. Splayed location.

- b. Knockout panels must be located no less than 6 inch from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - c. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 - d. Knockout panels must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - e. Knockout panels must be 1-1/2 to 2 inch thick.
8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
- a. Type and size: Match fittings to duct to be terminated.
 - b. Fittings must align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
 - c. Provide minimum of one cast end-bell or duct-terminating fitting of each size provided in each wall.
9. Handholes 12 inch wide by 24 inch long and larger must have inserts for cable racks and pulling-in irons installed before concrete is poured.
- C. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover:
1. Description: Molded of sand, concrete, and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or combination.
 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Oldcastle Infrastructure Inc.; CRH Americas.
 - b. Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated.
 3. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and installed location.
 - a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - b. Cover Legend: Molded lettering, as indicated for each service.
 5. Conduit Entrance Provisions: Conduit-terminating fittings must mate with entering ducts for secure, fixed installation in enclosure wall.
 6. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
 7. Handholes 12 inch wide by 24 inch long and larger must have factory-installed inserts for cable racks and pulling-in irons.
 8. Options:
 - a. Color: Gray or Green.

2.9 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. ASTM C858 for design and manufacturing processes.
 - b. SCTE 77.

B. Precast Concrete Manholes:

1. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Oldcastle Infrastructure Inc.; CRH Americas.](#)
 - b. [Utility Concrete Products, LLC.](#)
 - c. [Utility Vault Co.](#)
3. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch vertically and horizontally to accommodate alignment variations.
 - a. Splayed location.
 - b. Knockout panels must be located no less than 6 inch from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - c. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 - d. Knockout panel must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - e. Knockout panels must be 1-1/2 to 2 inch thick.
4. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size: Match fittings to duct to be terminated.
 - b. Fittings must align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.
 - c. Provide minimum of one cast end-bell or duct-terminating fitting of each size provided in each wall.
5. Ground Rod Sleeve: Provide 3 inch PVC sleeve in manhole floors 2 inch from wall adjacent to, but not underneath, duct entering structure.
6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
7. Source Quality Control: Test and inspect in accordance with ASTM C1037.

2.10 DUCT SEALING

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. American Polywater Corporation.
 2. [Ideal Industries, Inc.](#)
 3. [TE Connectivity Ltd.](#)
- B. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Compound must be capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.
- C. Inflatable Duct-Sealing System: Wraparound inflatable bladder that seals ducts that are empty or containing conductors against air and water infiltration. System is suitable for use in steel, plastic, or concrete ducts and penetrations.

2.11 SOURCE QUALITY CONTROL

- A. Factory Tests for Handholes and Boxes:
1. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
 - a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
 - b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.
 2. Nonconforming Work:
 - a. Equipment that does not pass tests and inspections will be considered defective.
 3. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit

field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

- C. Clear and grub vegetation to be removed, and protect vegetation to remain in accordance with Section 31 10 00 "Site Clearing." Remove and stockpile topsoil for reapplication in accordance with Section 31 10 00 "Site Clearing."

3.2 SELECTION OF UNDERGROUND DUCTS

- A. Duct for Electrical Cables More Than 600 V: PVC-80 or PVC-40, concrete encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: PVC-40 concrete encased unless otherwise indicated.
- C. Duct for Electrical Branch Circuits: PVC-40, direct buried unless otherwise indicated.
- D. Underground Ducts Crossing Paved Paths Walks and Driveways: PVC-40 encased in reinforced concrete.
- E. Underground Ducts Crossing Roadways: PVC-40, encased in reinforced concrete.
- F. Stub-ups: Concrete encased, ERM-C-S.

3.3 SELECTION OF UNDERGROUND ENCLOSURES

- A. Handholes and Boxes:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-10] structural load rating.
 - 3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Cover design load must not exceed load rating of handhole or box.
- B. Manholes: Precast concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating in accordance with AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating in accordance with AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 31 20 00 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

3.5 INSTALLATION OF DUCTS AND DUCT BANKS

- A. Reference Standards:

- 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
- 2. Consult Architect for resolution of conflicting requirements.

- B. Special Techniques:

- 1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- 2. Steel raceway, bends, and fittings in single duct run or duct bank must be of same type.
- 3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
- 4. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to manhole or handhole.
- 5. Install expansion fitting near center of straight line duct with calculated expansion of more than 3/4 inch.
- 6. Curves and Bends:
 - a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inch, both horizontally and vertically, at other locations unless otherwise indicated.
 - b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of 48 inch. Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
 - c. Duct must have maximum of 180 degrees of bends between pull points.
- 7. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch of concrete for minimum of 12 inch on each side of coupling.
 - a. Install insulated grounding bushings on steel raceway terminations that are less than 12 inch below grade or floor level and do not terminate in hubs.
- 8. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above 104 deg F. Where environmental temperatures are calculated to rise above 104 deg F, and anywhere duct crosses above underground steam line,

- install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of 104 deg F.
9. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inch o.c. for 5 inch duct, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to end-bell spacing 10 ft from end bell, without reducing duct slope and without forming trap in line.
 - b. Grout end bells into structure walls from both sides to provide watertight entrances.
 10. Duct Terminators for Entrances to Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inch o.c. for 4 inch duct, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to terminator spacing 10 ft from terminator, without reducing duct line slope and without forming trap in line.
 11. Building Wall Penetrations: Make transition from underground duct to steel raceway at least 10 ft outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
 12. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch of concrete for minimum of 12 inch on each side of coupling.
 13. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig hydrostatic pressure.
 14. Pulling Cord: Install 200 lbf test nylon cord in empty ducts.
 15. Concrete-Encased Ducts and Duct Bank:
 - a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 31 20 00 "Earth Moving" for pipes 6 inch or less in nominal diameter.
 - b. Width: Excavate trench 3 inch wider than duct on each side.
 - c. Depth: Install so top of duct envelope is at least 24 inch below finished grade in areas not subject to deliberate traffic, and at least 30 inch below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
 - d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft of duct. Place spacers within 24 inch of duct ends. Stagger spacers approximately 6 inch between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

- f. Minimum Space between Ducts: 3 inch between edge of duct and exterior envelope wall, 2 inch between ducts for like services, and 12 inch between power and communications ducts.
- g. Elbows:
 - 1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
 - 2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.
- h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch from edge of equipment base.
 - 1) Stub-ups must be minimum 4 inch above finished floor and minimum 3 inch from conduit side to edge of slab.
- i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups must finished floor and no less than 3 inch from conduit side to edge of slab.
- j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
- k. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
- l. Concrete Cover: Install minimum of 3 inch of concrete cover between edge of duct to exterior envelope wall, 2 inch between duct of like services, and 4 inch between power and communications ducts.
- m. Place minimum 6 inch of engineered fill above concrete encasement of duct.
- n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - 1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
 - 2) If more than one pour is necessary, terminate each pour in vertical plane and install 3/4 inch reinforcing-rod dowels extending minimum of 18 inch into concrete on both sides of joint near corners of envelope.
- o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

16. Direct-Buried Duct and Duct Bank:

- a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 31 20 00 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inch in nominal diameter.
- b. Width: Excavate trench 3 inch wider than duct on each side.
- c. Depth: Install top of duct at least 36 inch below finished grade unless otherwise indicated.
- d. Set elevation of top of duct bank below frost line.
- e. Place minimum 3 inch of sand as bed for duct. Place sand to minimum of 6 inch above top level of duct.
- f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
- g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft of duct. Place spacers within 24 inch of duct ends. Stagger spacers approximately 6 inch between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
- h. Install duct with minimum of 3 inch between ducts for like services and 12 inch between power and communications duct.
- i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
- j. Install manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - 1) Couple RNC duct to steel raceway with adapters designed for this purpose, and encase coupling with minimum 3 inch of concrete.
 - 2) Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch from edge of base. Install insulated grounding bushings on terminations at equipment.
 - a) Stub-ups must be minimum 4 inch above finished base and minimum 3 inch from conduit side to edge of base.
 - 3) Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally on exterior of wall minimum of 60 inch from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 4) Stub-ups through interior floors must be minimum 4 inch above finished floor and no less than 3 inch from conduit side to edge of equipment pad or floor slab.
- k. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inch over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 20 00 "Earth Moving" for installation of backfill materials.

17. Warning Planks: Bury warning planks approximately 12 inch above direct-buried duct, placing them 36 inch o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each 12 inch increment of duct-bank width over nominal 18 inch. Space additional planks 12 inch apart, horizontally across width of ducts.
18. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 26 05 53 "Identification for Electrical Systems" no less than 12 inch above concrete-encased duct and duct banks and approximately 12 inch below grade. Align tape parallel to and within 3 inch of centerline of duct bank. Provide additional warning tape for each 12 inch increment of duct-bank width over nominal 18 inch. Space additional tapes 12 inch apart, horizontally across width of ducts.
19. Ground ducts and duct banks in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Precast Concrete Handholes and Manholes:
 - a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
 - b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from 1 inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
 - c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
2. Elevations:
 - a. Manhole Roof: Install with rooftop at least 15 inch below finished grade.
 - b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 - c. Install handholes with bottom below frost line, below grade.
 - d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
 - e. Where indicated, cast handhole cover frame integrally with handhole structure.
3. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
4. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

- b. Install chimney, constructed of cast-iron collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.
5. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes] after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 07 13 53 "Elastomeric Sheet Waterproofing". After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
6. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 07 11 13 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
7. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
8. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
9. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inch for manholes and 2 inch for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
10. Ground manholes, handholes, and boxes in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
4. Install handholes and boxes with bottom below frost line, below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. Ground handholes and boxes in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Nonconforming Work:

1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
2. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump, and building interiors affected by Work.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Pourable sealants.
7. Foam sealants.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. [Product Data](#): For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Advance Products & Systems, LLC](#).

- b. [CCI Piping Systems](#).
 - c. [Flexicraft Industries](#).
 - d. GPT; a division of EnPRO Industries.
 - e. Specified Technologies, Inc.
 2. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.
- B. Cast-Iron Wall Sleeves:
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [American Cast Iron Pipe Company](#).
 - b. [Flexicraft Industries](#).
 - c. [McWane Ductile](#).
 2. General Characteristics: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- C. PVC Pipe Sleeves:
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [CCI Piping Systems](#).
 - b. GPT; a division of EnPRO Industries.
 - c. [Metraflex Company \(The\)](#).
 2. General Characteristics: ASTM D1785, Schedule 40.
- D. PVC Molded Sleeves:
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business](#).
 - b. American Polywater Corporation.
 - c. [Arlington Industries, Inc.](#)
 - d. [Reliance Worldwide Corporation](#).
 - e. Roxtec Inc.
 2. General Characteristics: With nailing flange for attaching to wooden forms.
- E. Round, Galvanized-Steel, Sheet Metal Sleeves:
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Benefast](#).
 - b. Specified Technologies, Inc.

2. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Abesco Fire LLC.](#)
 - b. [Specified Technologies, Inc.](#)
 - c. [Wiremold; Legrand North America, LLC.](#)
2. General Characteristics:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch.
 - 2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.3 SLEEVE-SEAL SYSTEMS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [Advance Products & Systems, LLC.](#)
 2. American Polywater Corporation.
 3. [Flexicraft Industries.](#)
 4. [Proco Products, Inc.](#)
- B. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
- C. Options:
 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Holdrite; a division of Reliance Worldwide Corporation.](#)
- B. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Specified Technologies, Inc.
 2. [W. R. Meadows, Inc.](#)
- B. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 2. Design Mix: 5000 psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.6 POURABLE SEALANTS

- A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Carlisle Syntec Systems.](#)
 2. [GAF.](#)
 3. [Johns Manville; a Berkshire Hathaway company.](#)
 4. Specified Technologies, Inc.
- B. Performance Criteria:
1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 - a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sustainability Characteristics:
 - a. [Sealant must have a VOC](#) content of 25 g/L or less.

2.7 FOAM SEALANTS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Innovative Chemical Products \(Building Solutions Group\)](#).
 2. [The Dow Chemical Company](#).
- B. Performance Criteria:
1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.
 2. Sustainability Characteristics:
 - a. [Sealant must have a VOC](#) content of 25 g/L or less.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed or seismic criteria require different clearance.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch above finished floor level. Install sleeves during erection of floors.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for wall assemblies.

- C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- E. Underground, Exterior-Wall and Floor Penetrations:
 - 1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
 - 2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 26 05 44

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Bands.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

B. UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Brady Corporation.](#)
 - b. [LEM Products Inc.](#)
 - c. [Marking Services, Inc.](#)
 - d. [Seton Identification Products.](#)

- C. UL PGDQ2 - Self-Adhesive Wraparound Labels: Write-on, 3 mil thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Brady Corporation.](#)
 - b. [LEM Products Inc.](#)
 - c. [Marking Services, Inc.](#)
 - d. [Seton Identification Products.](#)
 2. Self-Lamination: Clear; UV-, weather-, and chemical-resistant; self-laminating, with protective shield over legend. Size labels such that clear shield overlaps entire printed legend.
 3. Marker for Labels:
 - a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

- D. UL PGDQ2 - Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Brady Corporation.](#)
 - b. [LEM Products Inc.](#)
 - c. [Marking Services, Inc.](#)
 - d. [Seton Identification Products.](#)
 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inch for raceway and conductors.
 - b. 3-1/2 by 5 inch for equipment.
 - c. As required by authorities having jurisdiction.

2.2 BANDS

- A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Brady Corporation.](#)
 - b. [Marking Services, Inc.](#)
 - c. [Seton Identification Products.](#)
- B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch long, with diameters sized to suit diameters and that stay in place by gripping action.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Brady Corporation.](#)
 - b. [Marking Services, Inc.](#)
 - c. [Panduit Corp.](#)

2.3 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Ideal Industries, Inc.](#)
 - b. [Marking Services, Inc.](#)
 - c. [Panduit Corp.](#)
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil thick by 1 to 2 inch wide; compounded for outdoor use.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Brady Corporation.](#)
 - b. [Marking Services, Inc.](#)
- C. Tape and Stencil: 4 inch wide black stripes on 10 inch centers placed diagonally over orange background and are 12 inch wide. Stop stripes at legends.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [LEM Products Inc.](#)
 - b. [Marking Services, Inc.](#)
 - c. [Seton Identification Products.](#)
- D. Floor Marking Tape: 2 inch wide, 5 mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Carlton Industries, LP.](#)
- b. [Seton Identification Products.](#)

E. Underground-Line Warning Tape:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Brady Corporation.](#)
 - b. [LEM Products Inc.](#)
 - c. [Marking Services, Inc.](#)
 - d. [Seton Identification Products.](#)
2. **Tape:**
 - a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape must be permanent and may not be damaged by burial operations.
 - c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
3. **Color and Printing:**
 - a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
 - b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW".
 - c. Inscriptions for Orange Tapes: "CAUTION BURIED CATV LINE BELOW", "CAUTION BURIED TELEPHONE LINE BELOW", "CAUTION BURIED FIBER OPTIC LINE BELOW", and "CAUTION BURIED COMMUNICATION LINE BELOW".

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height must be 1 inch.

2.4 TAGS

A. Write-on Tags:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Carlton Industries, LP.](#)
 - b. [LEM Products Inc.](#)
 - c. [Seton Identification Products.](#)
2. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
3. Marker for Tags:
 - a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Carlton Industries, LP.
 - b. Marking Services, Inc.
2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4 inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inch.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4 inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inch.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brady Corporation.
 - b. Marking Services, Inc.
2. Engraved legend.
3. Thickness:
 - a. For signs up to 20 sq. inch, minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. inch, 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4 inch grommets in corners for mounting or Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 CABLE TIES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Ideal Industries, Inc.](#)
 2. [Marking Services, Inc.](#)
 3. [Panduit Corp.](#)
- B. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.
- C. UL ZODZ - General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black, except where used for color-coding.
- D. UL ZODZ - UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.
- E. UL ZODZ - Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F in accordance with ASTM D638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

- A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:
1. Fire-protection and fire-alarm] equipment, including raceways, must be finished, painted, or suitably marked safety red.
 2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft above finished floor.
- B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
1. Color must be factory applied or field applied for sizes larger than 6 AWG when permitted by authorities having jurisdiction].
 2. Colors for 208Y/120 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 3. Colors for 480Y/277 V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 4. Color for Neutral (Grounded Conductor): White (208Y/120 V) or gray (480Y/227 V).
 5. Color for Equipment Ground: Green (208Y/120 V) or green with yellow stripes (480Y/227 V).
 6. Color for Isolated Ground: Green with two or more yellow stripes.
- C. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- D. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:
1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
- E. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- F. Locations of Underground Lines: Underground-line warning tape for power and lighting.
- G. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
 2. Identify system voltage and system or service type with white letters on black field.
- H. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
 2. Identify system voltage and system or service type] with white letters on black field.
- I. Conductors to Be Extended in Future: Attach write-on tags to conductors and list source.
- J. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:
1. Panelboard designation.
 2. Colon or dash.
 3. Branch circuit number.
- K. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- L. Equipment Identification Labels:
1. Black letters on white field.
 2. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 3. Outdoor Equipment: Stenciled legend 4 inch high.
 4. Equipment to Be Labeled:
 - a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 - b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
 - c. Enclosures and electrical cabinets.
 - d. Access doors and panels for concealed electrical items.
 - e. Enclosed switches.
 - f. Enclosed circuit breakers.
 - g. Enclosed controllers.
 - h. Variable-speed controllers.
 - i. Contactors.
 - j. Remote-controlled switches, dimmer modules, and control devices.
 - k. Uninterruptible power supplies.
 - l. Battery-inverter units.
 - m. Monitoring and control equipment.
- M. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

- A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.
- B. Signs, labels, and tags required for personnel safety must comply with the following standards:
 1. Safety Colors: NEMA Z535.1.
 2. Facility Safety Signs: NEMA Z535.2.
 3. Safety Symbols: NEMA Z535.3.
 4. Product Safety Signs and Labels: NEMA Z535.4.
 5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.
- C. Electrical Hazard Warnings:
 1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with NFPA 70E and Section 26 05 73.19 "Arc-Flash Hazard Analysis" requirements for arc-flash hazard warning labels.
 2. Raceways and Cables Carrying Circuits at More Than 1000 V:
 - a. Black letters on orange field.
 - b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
 3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."
- D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
 1. Apply to exterior of door, cover, or other access.
 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Controls with external control power connections.
- E. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.

3.4 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

- A. Comply with Section 27 05 28 "Pathways for Communications Systems" and Section 27 11 00 "Communications Equipment Room Fittings."

3.5 INSTALLATION

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments specified in Section 26 00 11 "Facility Performance Requirements for Electrical."
- C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.
- E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- F. Install identifying devices before installing acoustical ceilings and similar concealment.
- G. Verify identity of item before installing identification products.
- H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- I. Apply identification devices to surfaces that require finish after completing finish work.
- J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- L. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- M. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.
- N. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

- O. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- P. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- Q. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- R. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- S. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape not less than 12 inch directly above cables or raceways buried 18 inch or more below grade. Use multiple tapes where width of multiple lines installed in common trench [**or concrete envelope**] exceeds 16 inch overall.
 - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- T. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
- U. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
- V. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 26 05 53

SECTION 26 05 73.19 - ARC-FLASH HAZARD ANALYSIS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- F. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Study Submittals:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form:
 - a. Arc-flash study input data, including completed computer program input data sheets.
 - b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - c. Revised one-line diagram, reflecting field investigation results and results of arc-flash study.

1.4 QUALITY ASSURANCE

- A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms must comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.

1.5 REGULATORY AGENCY APPROVALS

- A. Submittals for arc-flash hazard analysis requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. ETAP - Digital Twin Platform.
 2. EasyPower, LLC (formerly ESA Inc.).
 3. [Power Analytics, Corporation](#).
 4. [SKM Systems Analysis, Inc.](#)
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer program must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

- E. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kVA and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:
 - 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 symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.
- E. 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. Restricted approach boundary.
 - 6. Limited approach boundary.
 - 7. Working distance.
 - 8. Incident energy.
 - 9. Hazard risk category.
 - 10. Recommendations for arc-flash energy reduction.
- F. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce 3.5 by 5 inch self-adhesive equipment label for each work location included in analysis.
- B. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:
 - 1. Location designation.
 - 2. Nominal voltage.
 - 3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 - 4. Arc flash PPE category.
 - 5. Required minimum arc rating of PPE in Cal/cm squared.
 - 6. Available incident energy.
 - 7. Working distance.
 - 8. Engineering report number, revision number, and issue date.
- C. Labels must be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Calculate maximum and minimum contributions of fault-current size.
 - 1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
 - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
 - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
 - 4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

- C. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- D. Calculate limited, restricted, and prohibited approach boundaries for each location.
- E. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must take into account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:
 - 1. Fault contribution from induction motors must not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).
- F. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:
 - 1. When circuit breaker is in separate enclosure.
 - 2. When line terminals of circuit breaker are separate from work location.
- G. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain data necessary for conduct of arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
 - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to amount of detail that is required to be acquired in field. Field data gathering must be under direct supervision and control of engineer in charge of performing study, and must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Obtain electrical power utility impedance or available short circuit current at service.

3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

- A. Apply one arc-flash label on front cover of each section of equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below must have arc-flash label applied to it:
 1. Panelboards.
 2. Safety switches.
 3. Control panels.
- C. Note on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.
 1. Indicate arc-flash energy.
 2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

END OF SECTION 26 05 73.19

SECTION 26 09 23 - LIGHTING CONTROL DEVICES**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Electronic dial-time switches.
2. Electromechanical dial-time switches.
3. Outdoor photoelectric switches, solid state, flexible mounting.
4. Outdoor photoelectric switches, solid state, luminaire-mounted.
5. Outdoor photoelectric switches, low voltage.
6. Daylight-harvesting switching controls.
7. Daylight-harvesting dimming controls, analog.
8. Daylight-harvesting dimming controls, digital.
9. Indoor occupancy and vacancy sensors.
10. Switchbox-mounted occupancy sensors.
11. Digital timer light switch.
12. High-bay occupancy sensors.
13. Extreme-temperature occupancy sensors.
14. Outdoor motion sensors.
15. Lighting contactors.
16. Emergency shunt relay.
17. Conductors and cables.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 27 26 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Electronic dial-time switches.
2. Electromechanical dial-time switches.
3. Outdoor photoelectric switches, solid state, flexible mounting.
4. Outdoor photoelectric switches, solid state, luminaire-mounted.
5. Outdoor photoelectric switches, low voltage.
6. Daylight-harvesting switching controls.
7. Daylight-harvesting dimming controls, analog.
8. Daylight-harvesting dimming controls, digital.
9. Indoor occupancy and vacancy sensors.
10. Switchbox-mounted occupancy sensors.

11. Digital timer light switch.
12. High-bay occupancy sensors.
13. Extreme-temperature occupancy sensors.
14. Outdoor motion sensors.
15. Lighting contactors.
16. Emergency shunt relay.
17. Conductors and cables.

B. Shop Drawings:

1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranties.

1.4 WARRANTY

- A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Cooper Industries, Inc.](#)
2. [Intermatic, Inc.](#)
3. [Invensys Controls.](#)
4. [Leviton Manufacturing Co., Inc.](#)
5. [NSi Industries LLC.](#)
6. [TE Connectivity Ltd.](#)

- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Contact Configuration: SPST.
 3. Contact Rating: 30 A inductive or resistive, 240 V(ac).
 4. Programs:
 - a. Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 6. Astronomic Time: All channels.
 7. Automatic daylight savings time changeover.
 8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 ELECTROMECHANICAL DIAL-TIME SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Eaton.](#)
 2. Intermatic, Inc.
 3. [Leviton Manufacturing Co., Inc.](#)
 4. [Schneider Electric USA, Inc.](#)
- B. Electromechanical-Dial Time Switches: Comply with UL 917.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Contact Configuration: SPST.
 3. Contact Rating: 30 A inductive or resistive, 240 V(ac).
 4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
 5. Astronomic time dial.
 6. Eight-Day Program: Uniquely programmable for each weekday and holidays.
 7. Skip-a-day mode.
 8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Eaton](#).
 2. Intermatic, Inc.
 3. [Leviton Manufacturing Co., Inc.](#)
 4. nLight; Acuity Brands Lighting, Inc.
- B. Description: Solid state, with SPST dry contacts rated for 1000 W incandescent or 1800 VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range[, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 3. Time Delay: Fifteen-second minimum, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.
 5. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure from same source and manufacturer as switch.
 6. Failure Mode: Luminaire stays ON.

2.4 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, LUMINAIRE-MOUNTED

- A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Eaton](#).
 2. Intermatic, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. nLight; Acuity Brands Lighting, Inc.
- B. Description: Solid state, with SPST dry contacts rated for 1000 W incandescent or 1800 VA inductive, to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Twist lock complying with ANSI C136.10, with base from same source and manufacturer as switch.
 6. Failure Mode: Luminaire stays ON.

2.5 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

- A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Eaton](#).
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.
4. nLight; Acuity Brands Lighting, Inc.

B. Description: Solid state; one set of NO dry contacts rated for 24 V(dc) at 1 A], to operate connected load, complying with UL 773, and compatible with luminaire power pack lighting control panelboard.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Mounting: 1/2 inch threaded male conduit.
5. Failure Mode: Luminaire stays ON.
6. Power Pack:
 - a. Dry contacts rated for 20 A] ballast or LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
 - 1) LED status lights to indicate load status.
 - 2) Plenum rated.
 - b. Digital controller capable of accepting three] 8PSJ inputs with two outputs rated for 20 A incandescent or LED load at 120 and 277 V(ac), for 13 A 16 A ballast or LED at 120 and 277 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), Class 2 power source.
 - 1) With integral current monitoring.
 - 2) Compatible with digital addressable lighting interface.
 - 3) Plenum rated.

2.6 DAYLIGHT-HARVESTING DIMMING CONTROLS, ANALOG

A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Eaton](#).
2. [Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated](#).
3. [Leviton Manufacturing Co., Inc.](#)
4. [Lithonia Lighting; Acuity Brands Lighting, Inc.](#)
5. [WattStopper; Legrand North America, LLC](#).

B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack, to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Sensor Output: zero to 10 V(dc) to operate luminaires. Sensor is powered by controller unit.
 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- E. Power Pack: Dry contacts rated for 20 A] ballast or LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source
 1. LED status lights to indicate load status.
 2. Plenum rated.

2.7 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

- A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [Eaton](#).
 2. [Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated](#).
 3. [Leviton Manufacturing Co., Inc.](#)
 4. [Lithonia Lighting; Acuity Brands Lighting, Inc.](#)
 5. [WattStopper; Legrand North America, LLC](#).
 6. nLight; Acuity Brands Lighting, Inc.
- B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
 1. Lighting control set point is based on the following two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack, to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Sensor Output: zero to 10 V(dc) to operate luminaires. Sensor is powered by controller unit.
 - 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- E. Power Pack: Digital controller capable of accepting three] 8PSJ inputs with one output(s) rated for 20 A incandescent or LED load at 120 and 277 V(ac), for 13 A 16 A ballast load or LED at 120 and 277 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc) Class 2 power source.
 - 1. With integral current monitoring.
 - 2. Compatible with digital addressable lighting interface.
 - 3. Plenum rated.

2.8 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. nLight; Acuity Brands Lighting, Inc.
- B. General Requirements for Sensors:
 - 1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 - 2. Dual technology.
 - 3. Separate power pack.
 - 4. Hardwired connection to switch; and BAS and lighting control system.
 - 5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 7. Sensor Output: Sensor is powered from the power pack.
 - 8. Power: Line voltage.

9. Power Pack: Dry contacts rated for 20 A ballast or LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
 10. Mounting:
 - a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
 - b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 12. Bypass Switch: Override the "on" function in case of sensor failure.
 13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 2000 sq. ft. when mounted 48 inch above finished floor.

2.9 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. [Manufacturers](#): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [Eaton](#).
 2. [Hubbell Control Solutions; brand of Hubbell Electrical Solutions; Hubbell Incorporated](#).
 3. Leviton Manufacturing Co., Inc.
 4. [Lithonia Lighting; Acuity Brands Lighting, Inc.](#)
 5. [Sensor Switch, Inc.](#)
 6. [WattStopper; Legrand North America, LLC](#).
 7. nLight; Acuity Brands Lighting, Inc.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, using hardwired connection.
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application

2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800 VA ballast or LED load at 120 V, 1200 VA ballast or LED load at 277 V, and 800 W incandescent.

C. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft..
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Dual voltage - 120 and 277 V.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
9. Color: By the Architect.
10. Faceplate: Color matched to switch.

D. Wall-Switch Sensor Tag WS2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
2. Sensing Technology: PIR.
3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Dual voltage, 120 and 277 V.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: By the Architect.
11. Faceplate: Color matched to switch.

2.10 DIGITAL TIMER LIGHT SWITCH

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Intermatic, Inc.
2. Leviton Manufacturing Co., Inc.
3. nLight; Acuity Brands Lighting, Inc.

- B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in **[10] [20]** minute increments.
1. Rated 960 W at 120 V(ac) for tungsten lighting, 10 A at 120 V(ac) or 10 A at 277 V(ac) for fluorescent or LED lighting, and 1/4 hp at 120 V(ac).
 2. Standards: Comply with UL 20.
 3. Integral relay for connection to BAS.
 4. Voltage Dual voltage - 120 and 277 V.
 5. Color: By the Architect.
 6. Faceplate: Color matched to switch.

2.11 LIGHTING CONTACTORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [ABB, Electrification Business.](#)
 2. [ASCO Power Technologies.](#)
 3. [Eaton.](#)
 4. [Leviton Manufacturing Co., Inc.](#)
 5. [Square D; Schneider Electric USA.](#)
- B. Description: Electrically operated and mechanically or electrically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.12 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.3 INSTALLATION OF CONTACTORS

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 26 05 53 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
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.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

END OF SECTION 26 09 23

SECTION 26 09 43.23 - RELAY-BASED LIGHTING CONTROLS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Lighting control relay panels.
2. Networked lighting control panels.
3. Manual switches and cover plates.
4. Field-mounted signal sources.
5. Conductors and cables.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and cover plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.

B. Shop Drawings: For each relay panel and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than Type 1.
3. Detail wiring partition configuration, current, and voltage ratings.
4. Short-circuit current rating of relays.

5. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.
6. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.
7. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
 - a. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.
 - b. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panels for installation in accordance with NECA 407.

1.6 WARRANTY

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that components of standalone multipreset modular dimming controls perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended warranty period.
 1. Initial Extended Warranty Period: Two year(s) from date of Substantial Completion, for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Sequence of Operations: Input signal from field-mounted manual switches, or digital signal sources, must open or close one or more lighting control relays in the lighting control panels. Any combination of inputs must be programmable to any number of control relays.
- B. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.
- C. 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.

- D. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
- E. Comply with UL 916.

2.2 LIGHTING CONTROL RELAY PANELS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [General Electric Company.](#)
 - 2. [Leviton Manufacturing Co., Inc.](#)
 - 3. [Lightolier; a Philips group brand.](#)
 - 4. [Lithonia Lighting; Acuity Brands Lighting, Inc.](#)
 - 5. [Siemens Energy.](#)
 - 6. [WattStopper.](#)
- B. Description: Standalone lighting control panel using mechanically latched relays to control lighting and appliances.
- C. Lighting Control Panel:
 - 1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
 - 2. A vertical barrier separating branch circuits from control wiring.
- D. Control Unit: Contain the power supply and electronic control for operating and monitoring individual relays.
 - 1. Timing Unit:
 - a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
 - b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
 - c. Four independent schedules, each having 24 time periods.
 - d. Schedule periods settable to the minute.
 - e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
 - f. 10 special date periods.
 - 2. Sequencing Control with Override:
 - a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
 - b. Sequencing control must operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - c. Override control must allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
 - d. Override control "blink warning" must warn occupants approximately five minutes before actuating the off sequence.

3. Nonvolatile memory must retain all setup configurations. After a power failure, the controller must automatically reboot and return to normal system operation, including accurate time of day and date.

E. Relays:

1. Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating must be not less than 5 kA. Control must be three-wire, 24 V(ac).
2. Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V for tungsten, 30 A at 277 V for ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating must be not less than 14 kA. Control must be three-wire, 24 V(ac).

- F. Power Supply: NFPA 70, Class 2, sized for connected equipment, plus 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, control-voltage inputs, field-installed occupancy sensors, and photo sensors.

G. Operator Interface:

1. Integral alphanumeric keypad and digital display, and intuitive drop-down menus to assist in programming.
2. Log and display relay on-time.
3. Connect relays to one or more time and sequencing schemes.

2.3 NETWORKED LIGHTING CONTROL PANELS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [General Electric Company.](#)
2. [Lithonia Lighting: Acuity Brands Lighting, Inc.](#)
3. [WattStopper.](#)

- B. Description: Lighting control panels using mechanically latched relays to control lighting and appliances. The panels must be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.

C. Lighting Control Panels:

1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.
2. A vertical barrier separating branch circuits from control wiring.

- D. Main Control Unit: Installed in the main lighting control panel only; powered from the branch circuit of the standard control unit.

1. Ethernet Communications: Comply with TCP/IP protocol. The main control unit must provide for programming of all control functions of the main and all networked slave lighting control panels including timing, sequencing, and overriding.

2. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.
 - a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
 - b. Panel summary showing the master and slave panels connected to the controller.
 - c. Controller diagnostic information.
 - d. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens must also allow direct breaker control and zone overrides.
 3. Timing Unit:
 - a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
 - b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
 - c. Four independent schedules, each having 24 time periods.
 - d. Schedule periods settable to the minute.
 - e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
 - f. 16 special date periods.
 4. Time Synchronization: The timing unit must be updated not less than every 24 hour(s) with the network time server.
 5. Sequencing Control with Override:
 - a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
 - b. Sequencing control must operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
 - c. Override control must allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
 - d. Override control "blinking warning" must warn occupants approximately five minutes before actuating the off sequence.
 - e. Activity log, storing previous relay operation, including the time and cause of the change of status.
 - f. Download firmware to the latest version offered by manufacturer.
- E. Standard Control Unit, Installed in All Lighting Control Panels: Contain electronic controls for programming the operation of the relays in the control panel, contain the status of relays, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.
1. Electronic control for operating and monitoring individual relays, and display relay on-time.
 2. Nonvolatile memory must retain all setup configurations. After a power failure, the controller must automatically reboot and return to normal system operation.
 3. Integral keypad and digital-display front panel for local setup, including the following:
 - a. Blink notice, time adjustable from software.
 - b. Ability to log and display relay on-time.
 - c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.

- F. Relays:
1. Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating must be not less than 5 kA. Control must be three-wire, 24 V(ac).
 2. Electrically operated, mechanically held single-pole switch, rated at 20 A at 120 V for tungsten, 30 A at 277 V for ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating must be not less than 14 kA. Control must be three-wire, 24 V(ac).
- G. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, control-voltage inputs, field-installed occupancy sensors, and control-voltage photo sensors.
- H. Operator Interface: At the main control unit, provide interface for a tethered connection of a portable PC running MS Windows for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Owner's personnel. That device must remain the property of Owner.
- I. Software:
1. Menu-driven data entry.
 2. Online and offline programming and editing.
 3. Provide for entry of the room or space designation for the load side of each relay.
 4. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.
 5. Size the software appropriate to the system.

2.4 MANUAL SWITCHES AND COVER PLATES

- A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.
1. Match color and style specified in Section 26 27 26 "Wiring Devices."
 2. Integral green LED pilot light to indicate when circuit is on.
 3. Internal white LED locator light to illuminate when circuit is off.
- B. Cover Plates: Single and multigang cover plates as specified in Section 26 27 26 "Wiring Devices."
- C. Legend: Engraved or permanently silk-screened on cover plate where indicated. Use designations indicated on Drawings.

2.5 FIELD-MOUNTED SIGNAL SOURCES

- A. Daylight Harvesting Switching Controls: Comply with Section 26 09 23 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal must be compatible with the relays.

- B. Indoor Occupancy Sensors and Extreme-Temperature Occupancy Sensors: Comply with Section 26 09 23 "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal must be compatible with the relays.

2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than **[No. 18]** **[No. 22]** **[No. 24]** AWG. Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than **[No. 14]** **[No. 16]** **[No. 18]** AWG. Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables."
- D. Twisted-Pair Data Cable: Category 5e or Category 6.
 - 1. Comply with requirements for twisted pair cabling in Section 26 05 23 "Control-Voltage Electrical Power Cables."
 - 2. Comply with requirements in Section 27 15 13 "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panels in accordance with NECA 407.
- B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING

- A. Wiring Methods:
 - 1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters.

2. Install cables in raceways and cable trays except within consoles, cabinets, desks, counters, accessible ceiling spaces, and gypsum board partitions where unenclosed wiring method may be used.
 3. Install conductors and cables concealed in accessible ceilings, walls, and floors where possible.
 4. Conceal raceway and cables except in unfinished spaces.
 5. Provide plenum-rated cable, where installed exposed or in open cable tray, within environmental airspaces, including plenum ceilings.
 6. Comply with requirements for cable trays specified in Section 26 05 36 "Cable Trays for Electrical Systems."
 7. Comply with requirements for raceways specified in Section 26 05 33.13 "Conduits for Electrical Systems."
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 INSTALLATION OF PANELS

- A. Install panels and accessories in accordance with NECA 407.
- B. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- C. Mount top of trim 90 inch above finished floor unless otherwise indicated.
- D. Mount panel cabinet plumb and rigid without distortion of box.
- E. Install filler plates in unused spaces.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."
- C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.
- D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers described below. Certify compliance with manufacturer's test parameters.
 - a. Circuit-Breaker Tests:
 - 1) Compare nameplate with Drawings and Specifications.
 - 2) Inspect physical and mechanical conditions.
 - 3) Inspect anchorage and alignment.
 - 4) Verify that the units are clean.
 - 5) Operate the circuit breaker to ensure smooth operation.
 - 6) Inspect bolted electrical connections for high resistance using one or more of the following methods:
 - a) A low-resistance ohmmeter.
 - b) Verify tightness of bolted electrical connections by calibrated torque wrench.
 - c) Thermographic survey.
 - 7) Inspect operating mechanism, contacts, and arc chutes in unsealed units.
 - 8) Perform adjustments for final protective device settings in accordance with the overcurrent protective device coordination study. Comply with requirements in Section 26 05 73.16 "Coordination Studies."
 - 9) Perform insulation resistance tests for one minute on each pole, phase-to-phase, and phase-to-ground with the circuit breaker closed and across each pole using manufacturer's published data.
 - 10) Perform a contact/pole-resistance test.
 - 11) 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 for one minute. Follow manufacturer's instructions for solid-state units.
 - 12) Determine long-time pickup and delay by primary current injection.
 - 13) Determine short-time pickup and delay by primary current injection.
 - 14) Determine ground-fault pickup and time delay by primary current injection.
 - 15) Determine instantaneous pickup by primary current injection.
 - 16) Test functions of the trip unit by means of secondary injection.
 - 17) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
 - 18) 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.
 - 19) Verify operation of charging mechanism.

B. Nonconforming Work:

1. Lighting control panel will be considered defective if it does not pass tests and inspections.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.6 SYSTEM STARTUP

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's instructions.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system in accordance with approved configuration schedules, time-of-day schedules, and input override assignments.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 26 09 43.23

SECTION 26 24 16 - PANELBOARDS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.
5. Disconnecting and overcurrent protective devices.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 00 11 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 DEFINITIONS

A. GFEP: Ground-fault equipment protection.

B. MCCB: Molded-case circuit breaker.

C. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.
5. Disconnecting and overcurrent protective devices.
6. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.

4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

B. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Recommended procedures for installing panelboards.
2. Recommended torque settings for bolted connections on panelboards.
3. Recommended temperature range for energizing panelboards.

C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
2. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation in accordance with NEMA PB 1.

1.8 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.
- B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.
 1. Extended-Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces defined in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 1. Rated for environmental conditions at installed location.

- a. Indoor Dry and Clean Locations: UL 50E, Type 1.
 2. Height: 7 ft maximum.
 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 7. 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: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- G. Incoming Mains:
1. Location: Top.
 2. Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating must run entire length of bus.
 - b. Bus must be fully rated for entire length.
 2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
 5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
 6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors must be sized for double-sized or parallel conductors as indicated on Drawings.
 7. Do not mount neutral bus in gutter.
 8. Split Bus: Vertical buses divided into individual vertical sections.
 9. Include instructions in "Conductor Connectors" Paragraph below if special sizing or oversizing of lugs is required, if allowing optional use of aluminum for circuits sized for copper conductors, or when upsizing conductors for voltage drop.

- I. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations must allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
 9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- J. Quality-Control Label: Panelboards or load centers must be labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers must have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- K. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 1. Percentage of Future Space Capacity: 10 percent.
- L. Panelboard Short-Circuit Current Rating:
 1. Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by qualified electrical testing laboratory recognized by authorities having jurisdiction. Include label or manual with size and type of allowable upstream and branch devices listed and labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series-connected short-circuit rating.
 - a. Panelboards rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.
 2. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.
 - a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

- M. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.2 ELECTRONIC-GRADE PANELBOARDS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [ABB, Electrification Business.](#)
 - 2. [Eaton.](#)
 - 3. [Siemens Industry, Inc., Energy Management Division.](#)
 - 4. [Square D; Schneider Electric USA.](#)
- B. Listing Criteria: NEMA PB 1; UL 67; and UL 1449 after installing SPD.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. Factory-Installed, Integral SPD:
 - 1. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than 100 kA. Peak surge current rating must be arithmetic sum of ratings of individual MOVs in given mode.
 - 2. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits may not exceed the following:
 - a. Line to Neutral: 700 V for 208Y/120 V.
 - b. Line to Ground: 700 V for 208Y/120 V.
 - c. Neutral to Ground: 700 V for 208Y/120 V.
 - d. Line to Line: 1200 V for 208Y/120 V.
 - 3. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits may 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.
 - 4. SCCR: Equal to SCCR of panelboard in which installed.
 - 5. Inominal Rating: 20 kA.
- G. Buses:
 - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
 - 2. Copper equipment and isolated ground buses.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. [ABB, Electrification Business.](#)
 2. [Eaton.](#)
 3. [Siemens Industry, Inc., Energy Management Division.](#)
 4. [Square D; Schneider Electric USA.](#)
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
 6. GFEP Circuit Breakers: Class B ground-fault protection (30 mA trip).
 7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
 8. Subfeed Circuit Breakers: Vertically mounted.
 9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.

- f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
 - i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 A must have interchangeable rating plugs or electronic adjustable trip units.
 - k. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - l. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - m. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
 - n. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - o. Multipole units enclosed in single housing with single handle.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 26 28 13 "Fuses."
 - 2. Fused Switch Features and Accessories:
 - a. Standard ampere ratings and number of poles.
 - b. Mechanical cover interlock with manual interlock override, to prevent opening of cover when switch is in on position. Interlock must prevent switch from being turned on with cover open. Operating handle must have lock-off means with provisions for three padlocks.
 - c. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards in accordance with NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 1.1.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Equipment Mounting:
 - a. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
 - b. Attach panelboard to vertical finished or structural surface behind panelboard.
 - c. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
 - d. Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
 - 2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
 - 3. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
 - 4. Mount top of trim 7.5 ft above finished floor unless otherwise indicated.
 - 5. Mount panelboard cabinet plumb and rigid without distortion of box.
 - 6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
 - 7. Install overcurrent protective devices and controllers not already factory installed.
 - a. Set field-adjustable, circuit-breaker trip ranges.
 - b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.
 - 8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
 - 9. Install filler plates in unused spaces.
 - 10. Stub four 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 inch empty conduits into raised floor space or below slab not on grade.
 - 11. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing].
 - 12. Mount spare fuse cabinet in accessible location.
- D. Interfaces with Other Work:
 - 1. 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, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- C. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.
- E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.
- F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- G. Circuit Directory:
 - 1. Provide directory card inside panelboard door, mounted in metal frame with transparent protective cover].
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
 - 2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
 - 3. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Perform optional tests. 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 infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- C. Nonconforming Work:
1. Panelboards will be considered defective if they do not pass tests and inspections.
 2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E. Manufacturer Services:
1. Engage factory-authorized service representative to support field tests and inspections.
- 3.5 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Special-purpose power outlet assemblies.
9. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Receptacles with arc-fault and ground-fault protective devices.
5. Locking receptacles.
6. Pin-and-sleeve receptacles.
7. Special-purpose power outlet assemblies.
8. Connectors, cords, and plugs.

B. Shop Drawings:

1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Dimmers.
2. Fan-speed controllers.
3. Single straight-blade receptacles.

4. Duplex straight-blade receptacles.
5. Duplex straight-blade receptacles with integral switching means.
6. Hospital-grade straight-blade receptacles.
7. Receptacles with AFCI device.
8. Receptacles with AFCI and GFCI devices.
9. Receptacles with GFCI device.
10. Locking receptacles.
11. Pin-and-sleeve receptacles.
12. Spring-driven commercial/industrial-use cord reels.
13. Cord reels for use in hazardous locations.

1.4 CLOSEOUT SUBMITTALS

1.5 WARRANTY FOR DEVICES

- A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.
 1. Initial Extended Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

- A. Toggle Switch:
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Arrow Hart, Wiring Devices; Eaton, Electrical Sector.](#)
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. [Leviton Manufacturing Co., Inc.](#)
 - d. [Pass & Seymour; Legrand North America, LLC.](#)
 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 3. General Characteristics:
 - a. Reference Standards: UL CCN WMUZ and UL 20.
 4. Options:
 - a. Device Color: As indicated on architectural Drawings.
 - b. Configuration:

- 1) General-duty, 120-277 V, 20 A, single pole.
5. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- 2.2 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES
- A. Duplex Straight-Blade Receptacle:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour; Legrand North America, LLC.
 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 3. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 4. Options:
 - a. Device Color: As indicated on architectural Drawings.
 - b. Configuration:
 - 1) General-duty, NEMA 5-20R.
 5. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
 - B. Tamper-Resistant Duplex Straight-Blade Receptacle:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Leviton Manufacturing Co., Inc.

- d. [Pass & Seymour; Legrand North America, LLC.](#)
 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 3. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 4. Options:
 - a. Device Color: As indicated on architectural Drawings.
 - b. Configuration:
 - 1) General-duty, NEMA 5-20R.
 5. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- C. Isolated Ground Duplex Straight-Blade Receptacle:
1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - b. [Leviton Manufacturing Co., Inc.](#)
 - c. [Pass & Seymour; Legrand North America, LLC.](#)
 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 3. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 4. Options:
 - a. Device Color: As indicated on architectural Drawings.
 - b. Configuration:
 - 1) General-duty, NEMA 5-20R.
 5. Accessories:

- a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.3 RECEPTACLES WITH ARC-FAULT AND GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour; Legrand North America, LLC.
2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
 - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
4. Options:
 - a. Device Color: As indicated on architectural Drawings.
 - b. Configuration: Heavy-duty, NEMA 5-20R.
5. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

B. Cord Reels:

1. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation.

2. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONTROLLED AND UNCONTROLLED RECEPTACLES

3.3 INSTALLATION OF SWITCHES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
 3. Consult Architect for resolution of conflicting requirements.
- C. Identification:
 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.4 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 26 05 53 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.5 FIELD QUALITY CONTROL OF SWITCHES

- A. Tests and Inspections:

1. Perform tests and inspections in accordance with manufacturers' instructions.

B. Nonconforming Work:

1. Unit will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.6 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.7 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 27 26

SECTION 26 28 13 - FUSES**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Enclosed controllers.
 - c. Enclosed switches.
2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 2. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 1. Current-limitation curves for fuses with current-limiting characteristics.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [Bussmann; Eaton, Electrical Sector.](#)
 2. [Littelfuse, Inc.](#)
 3. [Mersen USA.](#)
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 1. Type RK-1: 250-V, zero- to 600-A rating, 200 kAIC, time delay.
 2. Type RK-5: 250, 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
 4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Motor Branch Circuits: Class RK1, time delay.
 - 2. Large Motor Branch (601-4000 A): Class L, time delay.
 - 3. Other Branch Circuits: Class RK1, time delay.
 - 4. Control Transformer Circuits: Class CC, time delay, control transformer duty.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

A. GFEP: Ground-fault circuit-interrupter for equipment protection.

B. GFLS: Ground-fault circuit-interrupter for life safety.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. 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.

1.4 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSIBLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [ABB, Electrification Business.](#)
 2. [Eaton.](#)
 3. [Siemens Industry, Inc., Energy Management Division.](#)
 4. [Square D; Schneider Electric USA.](#)
- B. Type HD, Heavy Duty:
 1. Single throw.
 2. Three pole.
 3. 240 V(ac).

4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
6. 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. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating -120 V(ac).
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [ABB, Electrification Business.](#)
2. [Eaton.](#)
3. [Siemens Industry, Inc., Energy Management Division.](#)
4. [Square D; Schneider Electric USA.](#)

- B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 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. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating -120 V(ac).
5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [ABB, Electrification Business.](#)
2. [Eaton.](#)

3. [Siemens Industry, Inc., Energy Management Division.](#)
 4. [Square D; Schneider Electric USA.](#)
- 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. Circuit breakers must be 100 percent rated.
- E. MCCBs must be equipped with device for locking in isolated position.
- F. Lugs must be suitable for 60 deg C rated wire on 125 A circuit breakers and below.
- 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. 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. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- M. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).

- N. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).
- O. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 3. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 4. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 5. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered] type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.5 MOLDED-CASE SWITCHES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [ABB, Electrification Business.](#)
 - 2. [Eaton.](#)
 - 3. [Siemens Industry, Inc., Energy Management Division.](#)
 - 4. [Square D; Schneider Electric USA.](#)
- 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 60 deg C rated wire on 125 A circuit breakers and below.
 - 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - 6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

2.6 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: Enclosure must be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1) gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (UL 50E Types 3R, 12).
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover] directly operable through dead front trim of enclosure (UL 50E Type 3R). 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

- A. Indoor, Dry and Clean Locations: UL 50E, Type 1.
- B. Outdoor Locations: UL 50E, Type 3R.
- C. Kitchen or Wash-Down Areas: UL 50E, Type 4X.
- D. Other Wet or Damp, Indoor Locations: UL 50E, Type 4.

3.3 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. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
4. Install fuses in fusible devices.

3.4 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. 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 fuseholder. 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.
- B. 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. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
 - g. 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.
 - h. 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.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Test and adjust controls, remote monitoring, and safeties.

C. 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.
- D. 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.
- 3.6 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 to values indicated on Drawings.
- 3.7 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.

END OF SECTION 26 28 16

SECTION 26 29 13.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Manual motor controllers.
2. Enclosed full-voltage magnetic motor controllers.
3. Combination full-voltage magnetic motor controllers.
4. Enclosed reduced-voltage magnetic motor controllers.
5. Combination reduced-voltage magnetic motor controllers.
6. Multispeed magnetic motor controllers.
7. Combination multispeed magnetic motor controllers.
8. Enclosures.
9. Accessories.
10. Identification.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SCPD: Short-circuit protective device.

1.4 ACTION SUBMITTALS

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

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of magnetic controller.
1. Include plans, elevations, sections, and mounting details.
 2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
 3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. 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. Differentiate between manufacturer-installed and field-installed wiring.
 4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- C. Product Schedule: List the following for each enclosed controller:
1. Each installed magnetic controller type.
 2. NRTL listing.
 3. Factory-installed accessories.
 4. Nameplate legends.
 5. SCCR of integrated unit.
 6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
 - a. Listing document proving Type 2 coordination.
 7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.
1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
 - a. Routine maintenance requirements for magnetic controllers and installed components.
 - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - c. Manufacturer's written instructions for setting field-adjustable overload relays.
 - d. 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.
 - e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one] spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

PART 2 - PRODUCTS

2.1 PERFORMANCE 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 use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.
- D. Seismic Performance: Magnetic controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the controller will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 MANUAL MOTOR CONTROLLERS

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Motion Business.](#)
 - b. [Eaton.](#)
 - c. [Siemens Industry, Inc., Energy Management Division.](#)
 - d. [Square D; Schneider Electric USA.](#)
2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
3. Configuration: Nonreversing.
4. Surface mounting.
5. Red pilot light.

- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Eaton.](#)
 - c. [Siemens Industry, Inc., Energy Management Division.](#)
 - d. [Square D; Schneider Electric USA.](#)
2. Configuration: Nonreversing.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Overload Relays: NEMA ICS 2, bimetallic class as schedule on Drawings.
5. Pilot Light: Red.

- C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB, Electrification Business.](#)
 - b. [Eaton.](#)
 - c. [Siemens Industry, Inc., Energy Management Division.](#)
 - d. [Square D; Schneider Electric USA.](#)

2. Configuration: Nonreversing.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Overload Relays: NEMA ICS 2, bimetallic class as scheduled on Drawings.

2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [ABB, Electrification Business.](#)
 2. [Eaton.](#)
 3. [Siemens Industry, Inc., Energy Management Division.](#)
 4. [Square D; Schneider Electric USA.](#)
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.
 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. Spare CPT Capacity as Indicated on Drawings: 100 VA.
- G. Overload Relays:
 1. Thermal Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - e. Automatic resetting.
 2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.

- c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- d. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.4 ENCLOSED REDUCED-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Electrically held; closed-transition; adjustable time delay on transition, 600-V ac or less.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [ABB, Electrification Business.](#)
 2. [Eaton.](#)
 3. [Siemens Industry, Inc., Energy Management Division.](#)
 4. [Square D; Schneider Electric USA.](#)
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration:
 1. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
 2. Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
 3. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
- E. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.
 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 1. Spare CPT Capacity: 50 VA.
- G. Overload Relays:
 1. Thermal Overload Relays: Melting alloy type.
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.

- c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - e. Automatic resetting.
2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.5 ENCLOSURES

- A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.
- B. The construction of the enclosures shall comply with NEMA ICS 6.
- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.6 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
 - a. Push Buttons: As indicated in the controller schedule.
 - b. Pilot Lights: As indicated in the controller schedule.
- B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.
 1. Phase-failure.
 2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
 3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

2.7 IDENTIFICATION

- A. Controller Nameplates: Baked enamel signs or Laminated acrylic or melamine plastic signs, as described in Section 26 05 53 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

- B. Arc-Flash Warning Labels:
 - 1. Comply with requirements in Section 26 05 73.19 "Arc-Flash Hazard Analysis." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
 - 2. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
 - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1) Location designation.
 - 2) Nominal voltage.
 - 3) Flash protection boundary.
 - 4) Hazard risk category.
 - 5) Incident energy.
 - 6) Working distance.
 - 7) Engineering report number, revision number, and issue date.
 - b. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Comply with NECA 1.

- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems" unless otherwise indicated.

- C. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

- D. Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- G. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify the unit is clean.
 - e. Inspect contactors:
 - 1) Verify mechanical operation.
 - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - f. Motor-Running Protection:
 - 1) Verify overload element rating is correct for its application.
 - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS

Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

- h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
- a. 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. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
 - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - c. Test motor protection devices according to manufacturer's published data.
 - d. Test circuit breakers as follows:
 - 1) Operate the circuit breaker to ensure smooth operation.
 - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
 - e. Perform operational tests by initiating control devices.
- B. Motor controller will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- 3.5 SYSTEM FUNCTION TESTS
- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
 - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
 - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
 - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
 - B. Motor controller will be considered defective if it does not pass the system function tests and inspections.
 - C. Prepare test and inspection reports.

END OF SECTION 26 29 13.03

SECTION 26 43 13 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Type 1 surge protective devices (SPDs).
2. Conductors and cables.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 24 16 "Panelboards" for integral SPDs installed by panelboard manufacturer.
3. Section 26 27 26 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.2 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 overvoltages. 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. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

A. Product Data:

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.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [ABB, Electrification Business.](#)
 2. [Eaton.](#)
 3. [Leviton Manufacturing Co., Inc.](#)
 4. [Liebert; Vertiv Holdings Co.](#)
 5. [Schneider Electric USA, Inc.](#)
 6. [Siemens Industry, Inc., Energy Management Division.](#)
- B. Source Limitations: Obtain devices from single source from single manufacturer.
- C. General Characteristics:
 1. Reference Standards: UL 1449, Type 1.
 2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V power systems.
 3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
 4. 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 for 208Y/120 V.
 - b. Line to Line: 1200 V for 208Y/120 V.
 5. SCCR: Not less than 100 kA.
 6. I_n Rating: 20 kA.
- D. Options:
 1. Include integral disconnect switch.

2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include indicator light display for protection status.
4. Include audible alarm.
5. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
6. Include surge counter.

2.2 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.
- B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 26 05 19 "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.
- C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 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.

3.3 STARTUP SERVICE

- A. Complete startup checks in accordance with manufacturer's instructions.

END OF SECTION 26 43 13

SECTION 26 50 00 - LIGHTING**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Luminaires.
2. Luminaire fittings.
3. Lamps.

B. Related Requirements:

1. Section 26 00 10 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 23 "Control-Voltage Electrical Power Cables" specifies wiring connections installed by this Section.
3. Section 26 05 29 "Hangers and Supports for Electrical Systems" specifies channel and angle supports installed by this Section.
4. Section 26 05 53 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.
5. Section 26 09 23 "Lighting Control Devices" and Section 26 09 43.23 "Relay-Based Lighting Controls" specify manual or programmable control systems with low-voltage control wiring or data communication circuits installed by this Section.

1.2 DEFINITIONS

- A. BUG Rating: Backlight, uplight, and glare rating for light pollution from exterior luminaires.
- B. Correlated Color Temperature (CCT): The absolute temperature (in kelvins) of a blackbody whose chromaticity (color quality) most nearly resembles that of the light source.
- C. Color Rendering Index (CRI): The measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference light source. The lower the CRI of a light source, the more difficult it is to identify colors and stripes on electronic components and wiring.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For luminaires.

- a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
 - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.
 - b. Product Certificates: Include product certificates stating compliance with standards listed below, signed by manufacturer or fabricator.
 - 1) Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with current accreditation under National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
 - 2) Testing Agency Certified Data: For luminaires indicated on Lighting Fixture Schedule on Drawings, photometric data certified by qualified independent testing laboratory. Photometric data for remaining luminaires must be certified by manufacturer.
 - c. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - d. Include operating characteristics, electrical characteristics, and furnished accessories.
 - e. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
 - f. Include battery and charger data for emergency lighting units.
 - g. Include ballast factor.
 - h. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - i. Include photometric data and adjustment factors obtained from qualified laboratory tests.
 - j. Include manufacturer's sample warranty language.
2. For luminaire fittings.
- a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
 - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.

- b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - c. Include operating characteristics, electrical characteristics, and furnished accessories.
 - d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
 - e. Include manufacturer's sample warranty language.
3. For lamps.
- a. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
 - 1) If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - 2) Listing criteria identified in approval letter must match specified listing criteria. Approval of only equipment's enclosure is not considered approval of equipment for intended application.
 - 3) Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for similar products are not acceptable.
 - b. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - c. Include operating characteristics, electrical characteristics, and furnished accessories.
 - d. Include schedule of submitted lighting products. Arrange schedule and accompanying product data in order by luminaire and lamp designations indicated on Drawings.
 - e. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - f. Include manufacturer's sample warranty language.
- B. Sustainable Design Product Data:
1. For luminaires.
- a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
 - b. Energy Efficiency: Submit product certificate indicating luminaire is certified by Design Lights Consortium.
 - c. Energy Usage: Submit product data showing compliance with ASHRAE 90.1.
 - d. BUG Ratings: Submit product data indicating BUG ratings of all installed exterior luminaires.
 - e. Luminaire Calculations: Submit product data indicating lumen emittance and vertical illuminance.
 - f. Environmental Product Declaration: For each product.
 - g. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 - h. Third-Party Certifications: For each product.
 - i. Third-Party Certified Life Cycle Assessment: For each product.
2. For luminaire fittings.
- a. Environmental Product Declaration: For each product.
 - b. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

- c. Third-Party Certifications: For each product.
 - d. Third-Party Certified Life Cycle Assessment: For each product.
 - 3. For electric-discharge lamp control equipment.
 - a. Energy Usage: Submit product data showing compliance with ASHRAE 90.1.
 - b. Environmental Product Declaration: For each product.
 - c. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 - d. Third-Party Certifications: For each product.
 - e. Third-Party Certified Life Cycle Assessment: For each product.
 - 4. For lamps.
 - a. Mercury Content: For fluorescent, mercury vapor, metal halide, high-pressure-sodium, neon, and argon lamps, submit data indicating mercury content and lamp life.
 - b. Environmental Product Declaration: For each product.
 - c. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.
 - d. Third-Party Certifications: For each product.
 - e. Third-Party Certified Life Cycle Assessment: For each product.
- C. Shop drawings.
- D. Field quality-control reports.
- 1.4 CLOSEOUT SUBMITTALS
 - A. Warranty documentation.
- 1.5 MAINTENANCE MATERIAL SUBMITTALS
 - A. Spare parts.
 - B. Extra stock material.
- 1.6 DELIVERY, STORAGE, AND HANDLING
 - A. Protect exposed surface finishes on lighting equipment by applying strippable, temporary protective covering before shipping.

PART 2 - PRODUCTS

2.1 LUMINAIRES

A. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - b. See individual product types below for listing criteria.
 - c. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.
- B. Source Quality Control:
1. Compile and submit product data.
 2. Compile and submit sustainable design product data.
 3. Compile and submit samples.
- C. Luminaires:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cooper Lighting Solutions; Signify North America Corp.
 - b. Lightolier; brand of Signify North America Corp.
 - c. Lithonia Lighting; Acuity Brands Lighting, Inc.
 2. Source Limitations: Obtain products for this luminaire type from single manufacturer.
 3. Product Listing Criteria, LED: UL CCN IFAM; including UL 1598.
 4. Product Listing Criteria, Outdoor Canopy Luminaires: UL CCN IFAW; including UL 1598.
 5. Product Characteristics:
 - a. Openings: Doors, frames, and access panels must operate smoothly, not leak light under operating conditions, and permit relamping without use of tools or parts falling from enclosure.
 - b. Nominal Operating Voltage: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - c. Nominal Luminaire Operating Power Rating: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - d. CRI: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - e. Ballast or Driver Location: Internal or Remote.
 - f. Materials:
 - 1) Enclosure: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 2) Enclosure Ingress Protection Rating: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 3) Lenses, Diffusers, and Globes: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - g. LED Luminaires (UL CCN IFAM):
 - 1) Output Intensity: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 2) Efficacy: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 3) Rated Life: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 4) CCT: Refer to the Lighting Fixture Schedule on the Electrical Drawings.

6. Required Product Options:
- a. Mounting Hardware: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - b. Mounting Height: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - c. Bollard:
 - 1) Shape: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 2) Height from Finished Grade: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 3) Overall Height: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 4) Diameter: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - d. Decorative Post Top: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - e. Roadway Pole: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - f. Finishes:
 - 1) Enclosure: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 2) Reflector: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 3) Reflecting surfaces must have minimum reflectance as follows, unless otherwise indicated:
 - a) White Surfaces: 85 percent.
 - b) Specular Surfaces: 83 percent.
 - c) Diffusing Specular Surfaces: 75 percent.

7. Installation Markings:
- a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
 - b. All Luminaires (UL CCN HYXT).
 - c. LED Luminaires (UL CCN IFAM):

D. UL FTBR or FTBV - Emergency Lighting and Power Equipment:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cooper Lighting Solutions; Signify North America Corp.
 - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - c. Philips; Signify North America; Signify Holding.
2. Source Limitations: Obtain products from single manufacturer.
3. Product Description: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
4. Product Listing Criteria: UL CCN FTBR or UL CCN FTBV; including UL 924, NFPA 101, and ICC IBC.
5. Product Characteristics:
 - a. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - b. Status and Test Indication: Visible and accessible without opening luminaire or entering ceiling space.

- 1) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 2) Test Push-Button: Push-to-test button in unit housing simulates loss of normal power and demonstrates unit operability.
- c. Nominal Operating Voltage: 120 V(ac).
 - d. Mounting: Ceiling or Wall with universal junction box adaptor.
 - e. Enclosure: UV stable thermoplastic housing rated for damp or wet locations.
 - f. Flame Rating: UL 94 5VA.
 - g. Light Source: Two LED heads.
6. Required Product Options:
- a. Mounting Height: 7'-0" AFF.
 - b. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.
 - 1) Emergency Connection: Operate LED(s) continuously at a lumen output as stated in the Lighting Fixture Schedule' upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2) Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a) Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 3) Battery Type: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 4) Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 5) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - c. External Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
 - 1) Emergency Connection: Operate LED] lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2) 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.
 - 3) Nightlight Connection: Operate lamp in a remote luminaire continuously.
 - 4) Battery Type: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 5) Charger: Fully automatic, solid-state, constant-current type.
 - 6) Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by emergency power unit manufacturer, whichever is less.

- 7) Test Push-Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 8) LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 9) Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. Installation Markings:
- a. Relamping Labels: Include recommended lamp type, diameter, shape, size, wattage, and coating on factory-applied label that is visible when luminaire is open for relamping.
 - b. All Luminaires (UL CCN HYXT):
 - c. Emergency Lighting and Power Equipment (UL CCN FTBR):
- E. UL FWBO - Exit Fixture:
- 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cooper Lighting Solutions; Signify North America Corp.
 - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - c. Philips; Signify North America; Signify Holding.
 - 2. Source Limitations: Obtain products from single manufacturer.
 - 3. Product Description: Refer to the Lighting Fixture Schedule on the Electrical Drawings
 - 4. Product Listing Criteria: UL CCN FWBO; including UL 924, NFPA 101, and ICC IBC.
 - 5. Product Characteristics:
 - a. Nominal Operating Voltage: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - b. Light Source: LED; 50,000 hours minimum rated life.
 - c. Legend Color: [Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - d. Internal emergency power unit.
 - e. Battery Type: Refer to the Lighting Fixture Schedule on the Electrical Drawings.
 - 6. Installation Markings:
 - a. All Luminaires (UL CCN HYXT):
 - b. Exit Fixtures (UL CCN FWBO):

2.2 LUMINAIRE FITTINGS

A. Performance Criteria:

- 1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- b. See individual product types below for listing criteria.

B. Source Quality Control:

1. Compile and submit product data.
2. Compile and submit sustainable design product data.
3. Compile and submit samples.

C. Luminaire Support Accessories:

1. Product Characteristics:

- a. Sized and rated for luminaire weight.
- b. Capable of maintaining luminaire position after cleaning and relamping.
- c. Capable of supporting luminaire without causing deflection of ceiling or wall.
- d. Capable of supporting horizontal force equal to 100 percent of luminaire weight and vertical force equal to 400 percent of luminaire weight.

2. Required Product Options:

- a. Hook Hangers: Integrated assembly matched to luminaire, supply voltage, and equipment with threaded attachment, cord, and locking-type plug.
- b. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage wire supports length as required.
- c. Aircraft Cables: 5/32 inch diameter aircraft cable supports adjustable to 10 ft in length.
- d. Single-Stem Hangers: 1/2 inch nominal diameter steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- e. Rod Hangers: 3/16 inch nominal diameter, cadmium-plated, threaded steel rod.

2.3 LAMPS

A. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Source Quality Control:

1. Compile and submit product data.
2. Compile and submit sustainable design product data.
3. Compile and submit samples.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Shop Drawings: Prepare and submit the following:
 - 1. Drawings, Diagrams, and Supporting Documents for Custom Luminaires:
 - a. Include plans, elevations, sections, and mounting and attachment details.
 - b. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Include diagrams for power, signal, and control wiring.

3.3 INSTALLATION OF LIGHTING

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 - 1. Installation of Indoor Lighting Systems: NECA NEIS 500.
 - 2. Installation of Exterior Lighting Systems: NECA NEIS 501.
 - 3. Installation of Emergency Lighting and Exit Signs: ICC IBC, NFPA 101, and Parts IV and V in Article 700 of NFPA 70.
 - 4. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. Install luminaires level, plumb, and square with finished floor or grade unless otherwise indicated.
 - 2. Install luminaires at height and aiming angle as indicated on Drawings.
 - 3. Coordinate layout and installation of luminaires with other construction.
 - 4. Adjust luminaires that require field adjustment or aiming.
 - 5. Exterior Corrosion Prevention:

- a. Do not use aluminum in contact with earth or concrete. When in direct contact with dissimilar metals, protect aluminum with insulating fittings or treatment.
 - b. When embedding steel conduits in concrete, wrap conduit with 10 mil thick, pipe-wrapping plastic tape applied with a 50 percent overlap.
6. Flush-Mounted Luminaire Support:
- a. Secured to outlet box.
 - b. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - c. Trim ring flush with finished surface.
7. Wall-Mounted Luminaire Support:
- a. Attached to structural members in walls or attached using through bolts and backing plates on either side of wall.
 - b. Do not attach luminaires directly to gypsum board.
8. Suspended Luminaire Support:
- a. Ceiling Mount:
 - 1) Hook hangers.
 - 2) Two wires.
 - 3) Two or Four aircraft cables.
 - b. Pendants and Rods: Where longer than 48 inch, brace to limit swinging.
 - c. 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.
 - d. Continuous Rows of Luminaires: Provide tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - e. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
9. Ceiling-Grid-Mounted Luminaire Support:
- a. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each luminaire. Locate not more than 6 inch from luminaire corners.
 - b. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for application.
 - c. Luminaires of Sizes Smaller Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with no fewer than two 3/4 inch metal channels spanning and secured to ceiling tees.
 - d. Seismic Restraint: Install at least one independent support rod or wire from structure to tab on luminaire. Wire or rod must have breaking strength for luminaire weight with safety factor of 3.
10. Remote Mounting of Ballasts: Do not exceed distance between ballast and luminaire recommended by ballast manufacturer.
11. Emergency Power Units: Secure with approved fasteners in four or more locations, spaced near corners of unit.

12. Install wiring connections for luminaires.
13. Identification: Provide labels for luminaires and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Provide warning signs.
 - c. Label each enclosure with engraved metal or laminated-plastic nameplate.

- D. Systems Integration: Integrate lighting control devices and equipment with electrical power connections for operation of luminaires as specified.

3.4 FIELD QUALITY CONTROL OF LIGHTING

A. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
3. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
4. Verify operation of photoelectric controls.
5. Exterior Illumination Tests:
 - a. Measure light intensities at night. Use photometers with calibration referenced to NIST standards.

B. Nonconforming Work:

1. Luminaire will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Burn-in lamps that require specific aging period to operate properly, prior to occupancy by Owner.
3. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
4. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 PROTECTION

- A. After installation, protect lighting equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 50 00

SECTION 270000 – GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. The scope of work specified by these documents shall result in the provision, installation and testing of the following Telecommunications Communications infrastructure, systems and equipment. All cabling, outlets, faceplates, patch panels and patch cords shall match the phase 1 installed devices exactly.
- B. All equipment as part of the telecommunications communications infrastructure systems shall be procured through the OGS New York state Contract. Provide a complete bill of materials for procurement.
- C. The telecommunications contract shall install all equipment procured under the OGS New York State contract and warranty as described in the 27 series specifications.

1. Data Wiring

- a. Contractor to provide all new CAT6 cabling at all telecom outlet locations. Refer to drawings for outlet locations.
 - 1) All new CAT6 cables shall be terminated onto new CAT6 patch panels and labeled as indicated in Telecommunications Labeling Detail Sheet.
 - 2) Rhode Island College standard for category 6 cabling is
Voice and Data: Copper Cable, Cat6, 4-Pair, 23 AWG, U/UTP, CMR, CMP

M58280 Mohawk CAT6, Color White

M58281 Mohawk CAT6, Color Blue

M58283 Mohawk CAT6, Color Yellow

M71003 Coaxial RG-6U CMP Rated

2. Wireless Data Communication System (wiring only).

- a. All WAP locations are to receive new CAT6a cabling.
 - 1) Cables to be terminated onto individual CAT6a patch panels and shall not be shared with other telecommunications outlet types.
 - 2) Rhode Island College Standard for category 6A cabling is:
Wireless Access: Copper Cable, Cat6A, 4-Pair, 23 AWG, U/UTP, CMR, CMP
 - M59154 Mohawk CAT6A, Color Violet
 - M59152 Mohawk CAT6, Color Orange

6. The Telecommunications Contractor shall ensure that the General Contractor and Painting Contractor acknowledge that painting of or over spray any single or group of 4 pair horizontal telecommunications Category 5e or Category 6 cable is not allowed. Any painted or over sprayed cable(s) shall be replaced at the telecommunications and/or painting contractor's expense. Painted Cable will not be covered as part of an extended warranty. Painted cable in addition to obscuring the print legend may act as an accelerant or create an additional smoke hazard in the event of a fire and as such this is considered a life safety issue.
- B. Systems shall utilize digital technology to integrate the following systems into a single network linking them to a central site:
1. LAN/Wi-Fi Systems
 - a. For data communications, the existing Wide Area Network will be the central means of communicating throughout the campus for campus wide email, network access to shared files and Internet Access.
 - b. Locally, the facility will be provided with a Local Area Network for all local data and video connectivity.
 - c. Wireless Access Points (WAPs) shall be provided by Client.
 - d. All Wireless Access Point devices and switches shall be furnished, installed and configured by the owner.
 - e. All Network access layer, Network core, Network security devices shall be furnished, installed and configured by the owner.
 2. Security
 - a. Security devices shall be furnished, installed and configured by others:
 - 1) Provide the following cables from each door indicated to the comm room where the access control panel(s) are located
 - (1) 22/6 Shielded plenum cable
 - (2) 18/4 shielded plenum cables
 - (1)16/2 shielded plenum cable
 - 2) Coil 15 feet of cable at each end and label the cables on both ends with the door number.
- C. These systems shall be integrated by means of an in building Network of cables.
1. Cable Infrastructure
 - a. All technology cabling for the new school will be integrated with the data network, telephone, intercom, and security systems, utilizing Category 6A and SM Fiber Optic cabling.
 2. Cabling for data and telecommunications between the jack plate and either MDF or IDF shall be category 6 and/or 6A as indicated in drawings and field conditions.
 3. Based on distance limitations from MDF/IDF's to the classroom, the cabling distance standard of 290' for data networks shall be adhered to.
 4. All wiring will be in stub-ups or free air to J-hooks.

1.3 SUMMARY OF WORK

- A. Associated "T" drawing series attached

1.4 REGULATIONS AND CODE COMPLIANCE

- A. All work and materials shall conform to and be installed, inspected and tested in accordance with the most current governing rules and regulations of federal, state and local governmental agencies.
- B. The following is a list of codes and standards that will apply to this project:
 - 1. New York Uniform Fire Prevention and Building Code.
 - 2. New York Department of Labor Rules and Regulations.
 - 3. New York Department of Health.
 - 4. Federal Occupational Safety and Health Administration - OSHA.
 - 5. National Life Safety Code, NFPA 101.
 - 6. National Electrical Code (NEC), NFPA 70
 - 7. Underwriters Laboratory (UL).
 - 8. Factory Mutual and/or Owner's Insurance Carrier.
 - 9. ANSI/TIA - Telecommunications Building Wiring Standards (Most current addition, revision and addenda), including, but limited to, the following compilation series of documents: 568, 570, 598, 606, 607, 758, , FIP 174, FIP175, FIP176,
 - 10. BICSI Telecommunications Distribution Methods Manual, Telecommunications Cabling Installation Manual, Customer-Owned Outside Plant Manual, LAN and Internetworking Design Manual.
 - 11. IEEE Standards.
 - 12. IEEE-SA - National Electrical Safety Code (NESC)
 - 13. Federal Communications Commission.
 - 14. NEMA – National Electrical Manufacturers' Association
 - 15. CSA – Canadian Standards Association
 - 16. Owner's Environmental Health and Safety Standards.
 - 17. Owner's Construction Standards.
 - 18. ADA, Americans with Disabilities Act.

1.5 GLOSSARY

- A. ANSI: American National Standards Institute
- B. ASME: American Society of Mechanical Engineers
- C. ASTM: American Society for Testing Materials
- D. BICSI: Building Industry Consulting Services International
- E. CSA: Canadian Standards Association
- F. FCC: Federal Communications Commission
- G. FM: Factory Mutual Insurance Company
- H. IEEE: Institute of Electrical and Electronics Engineers

- I. IRI: Industrial Risk Insurers
- J. ISO: International Standards Organization
- K. NEC: National Electrical Code (latest applicable edition)
- L. NEMA: National Electrical Manufacturers' Association
- M. NESC: National Electrical Safety ode
- N. NFPA: National Fire Protection Association
- O. New York BFU: New York Board of Fire Underwriters
- P. New York /DEC: New York Department of Environmental Conservation
- Q. New York /UFBC: New York Uniform Fire Prevention and Building Code
- R. OSHA: Occupational Safety and Health Administration
- S. TIA: Telecommunications Industry Association
- T. UFPO: Underground Facilities Protective Organization
- U. UL: Underwriter's Laboratories, Inc.

1.6 DEFINITIONS

- A. Approved / Approval: Written permission to use a material or system.
- B. As Called for: Materials, equipment including the execution specified/shown in the contract documents.
- C. Code Requirements: Minimum requirements
- D. Concealed: Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
- E. Design Equipment: Refer to the article, BASIS OF DESIGN.
- F. Design Make: Refer to the Article, BASIS OF DESIGN.
- G. Equal or Equivalent: Equally acceptable as determined by Owner's Representative.
- H. Exposed: Work not identified as concealed.
- I. Final Acceptance: Owner acceptance of the project from Contractor upon certified by Owner's Representative.
- J. Furnish: Supply and deliver to installation location.

- K. Furnished by Others: Receive delivery at job site or where called for and installed.
- L. Inspection: Visual observations by Owner's site Representative.
- M. Install: Mount and connect equipment and associated materials ready for use.
- N. Labeled: Refers to classification by a standards agency.
- O. Make: Refer to the article, BASIS OF DESIGN.
- P. Or Approved Equal: Approved equal or equivalent as determined by Owner's Representative.
- Q. Owner's Representative: Mast Construction
- R. Prime Professional: Architect or Engineer having a contract directly with the Owner for professional services.
- S. Provide: Furnish, install and connect ready for use.
- T. Relocate: Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
- U. Replace: Remove and provide new item.
- V. Review: A general contractual conformance check of specified products. W. Roughing: Pipe, duct, conduit, cabling, equipment layout and installation.
- W. Satisfactory: As specified in contract documents.
- X. Site Representative: Construction Manager or Owner's Inspector at the work site.
- Y. Refer to General Conditions of the Contract for additional definitions.

1.7 INTENT OF DRAWINGS

- A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, and fixtures. Exact locations are subject to the approval of the Owner's Representative.
- B. The Contractor should verify all dimensions locating the work and its relation to existing work, all existing conditions and their relation to the work and all man-made obstructions and conditions, etc. affecting the completion and proper execution of the work as indicated in the Contract Documents.
- C. Related Documents
 - 1. Drawings, General Conditions, and Special Conditions related to this project are found in this Division, as well as the other Divisions included in the Contract Documents.

2.0 PRODUCTS

2.1 EQUIPMENT AND MATERIALS MINIMUM REQUIREMENTS:

A. Materials requirements:

1. All equipment and material for which there is a listing service shall bear a UL label.
2. Electrical equipment and systems shall meet UL Standards and requirements of the NEC and CSA. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with these requirements.
3. Equipment shall meet all applicable FCC Regulations
4. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.
5. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications and meet the quality of the design make.
6. Where applicable, all materials and equipment shall bear the label and listing of Underwriters Laboratory of Factory Mutual. Application and installation of all equipment and materials shall be in accordance with such labeling and listing.

2.3 CABLES

- A. Any cable associated with this Contract, passing through two or more floors shall be suitable, listed by a Nationally Recognized Testing Laboratory (NRTL) and marked for use in a riser or plenum application. Riser cable shall minimally be CMR or OFNR rated per the National Electrical Code and shall meet all local and state codes.
- B. Any cable associated with this Contract shall be rated, listed by a Nationally Recognized Testing Laboratory (NRTL) and marked for use in a plenum application, regardless if the ceiling is a ducted return air plenum or not. Cable shall be CMP rated per the National Electrical Code and shall meet all local and state codes.
- C. Voice copper backbone cables, if required, shall be twisted 24 AWG., contain a corrugated aluminum shield, be of the size indicated on the drawings and have the proper jacket classification per the NEC.
- D. All copper underground feeder cable associated with this Contract, if required, shall be suitable, listed and marked for use in a duct application per the National Electrical Code article 800 and shall meet all local codes. Copper underground cables shall be jell-filled, twisted 24 AWG., contain an overall corrugated shield, be of the size indicated on the drawings, shall have footage indicators imprinted on the cable jacket and shall meet REA/RUS specification PE-39 or PE-89.

2.4 FACTORY ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.

- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of same manufacturer.
 - 2. Constituent parts, which are alike, shall be product of a single manufacturer.
 - 3. Components shall be compatible with each other and with the total assembly for intended service.
- C. Components of equipment shall bear manufacturer's name or trademark, model number and serial number on a nameplate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment that serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

2.5 COMPATABILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.
- B. Provide maximum standardization of components to reduce spare part requirements.
- C. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of same manufacturer.
 - 2. Constituent parts that are alike shall be product of a single manufacturer.
 - 3. Components of equipment shall bear manufacturer's name or trademark, model number and serial number on a nameplate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

2.6 LIFTING ATTACHMENTS

- A. Equipment should have suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered without bending or distortion of shape, such as rapid lowering and braking of load.

2.7 MISCELLANEOUS SUPPORTS

- A. Metal bars, plates, tubing, etc. shall conform to the following ASTM standards:
 - 1. Steel plates, shapes, bars, and grating - ASTM A 36
 - 2. Cold-Formed Steel Tubing - ASTM A 500
 - 3. Hot - Rolled Steel Tubing - ASTM A 500
 - 4. Steel Pipe - ASTM A 53, Schedule 40, welded
- B. Metal Fasteners shall be Zinc-coated (type, grade and class as required)

2.8 FIRESTOPPING

- A. Firestopping for Openings through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Firestop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Firestops" designated ASTM E814.
- B. Inside of all conduits, the firestop system shall consist of a dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required). The sealant must be capable of being removed and reinstalled and must adhere to all penetrants and common construction materials and shall be capable of allowing normal wire/cable movement without being displaced.
- C. All conduit and sleeve openings shall be waterproofed or fireproofed in compliance with New Jersey Building and Fire Codes. Strict adherence to National and State Fire Codes, particularly firestopping will be required.
- D. All openings remaining around and inside all conduit, sleeves and cable penetrations to maintain the integrity of any fire rated wall, ceiling, floor, etc. shall be patched.
- E. All building conduits and sleeves installed and/or used under this contract shall be firestopped, or re-firestopped, upon cable placement through such passageways.
- F. Manufacturer's recommended installation standards must be closely followed (i.e. minimum depth of material, use of ceramic fiber and installation procedures).
- G. Provide firestop system seals at all locations where conduit, fiber, cable trays, cables/wires, and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide firestop seal between sleeve and wall for drywall construction.
- H. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the firestop system. The installation shall provide an air and watertight seal.
- I. The methods used shall incorporate qualities that permit the easy removal or addition of conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating. Typical rating:
 - 1. Floors - 3 hours
 - 2. Corridor walls - 2 hours
 - 3. Offices - $\frac{3}{4}$ hour
 - 4. Smoke partitions - $\frac{3}{4}$ - 1 hour
- J. Provide firestop pillows for existing cable tray penetrations through firewalls.

3. EXECUTION

3.1 ROUGH-IN

- A. Due to small scale of drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for installation with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough in work. If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owner's representative for approval before proceeding.
- B. All equipment locations shall be coordinated with other trades, other renovation projects, and existing conditions to eliminate interference with required clearances for equipment maintenance and inspection.
 - 1. Coordinate work with other trades, other renovation projects, and existing conditions to determine exact routing of all cable tray, hangers, conduit, etc., before fabrication and installation. Coordinate with Technology Drawings. Verify with Owners Representative exact location and mounting height of all equipment in finished areas, such as equipment racks, communication and electrical devices. Coordinate all work with existing Architecture.
 - 2. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. There will be no priority schedule for trades. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied or proposed, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.
- C. Provide easy, safe, and code mandated clearances at equipment racks and enclosures, and other equipment requiring maintenance and operation.

3.2 CUTTING AND PATCHING

- A. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch and/or paint openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

3.3 CONCEALMENT

- A. Use existing conduit and surface raceway where possible and practicable. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

3.4 CHASES

A. General

1. Field verifies for correct size and location for all openings, recesses and chase.
2. Assume responsibility for correct and final location and size of such openings.
3. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.
4. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all work and equipment damaged during course of drilling. Cap or firestop all unused conduits and sleeves.
5. Provide angle iron frame where openings are required for contract work.
6. Seal voids in fire rated assemblies with a firestopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge-galvanized sleeves at fire rated assemblies. Extend sleeves 2" above floors.
7. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide firestopping seal between sleeves and wall in drywall construction. Provide firestopping similar to that for floor openings.

3.5 WATERPROOFING

- A. The Contractor shall seal all foundation penetrating conduits and all service entrance conduits and sleeves to eliminate the intrusion of moisture and gases into the building. This requirement also includes spare conduits.
- B. Spare conduits shall be plugged with expandable plugs.
- C. All service entrance conduits through building shall be sealed or resealed upon cable placement.
- D. Conduits with cables in them shall be permanently sealed by firmly packing the void around the cable with oakum and capping with a hydraulic cement or waterproof duct seal.

3.6 SUPPORTS

- A. Provide required supports, beams, angles, hangers, rods, bases, braces, straps, struts, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For precast Panels/Planks and Metal Decks, support communication work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

3.7 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.
- B. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
- C. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
- D. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
- E. No equipment shall be hidden or covered up prior to inspection by the owner's representative. All work that is determined to be unsatisfactory shall be corrected immediately.
- F. All work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

3.8 IMPLEMENTATION

- A. The contractor shall provide and install all hardware, software, connections and appurtenances required for fully operational systems.

END OF SECTION 270000

SECTION 270528 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Conduit, fittings and bodies, including multi-cell conduit.
 2. Riser flexible raceway (inner duct) and fittings.
 3. Junction boxes pull boxes and gutters.
 4. Measured pull tape.
 5. J-Hooks.
 6. Wire Tray / Ladder Rack.

1.2 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts:
1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- D. References:
1. American National Standards Institute (ANSI):
 - a. C80.1 Rigid Steel Conduit - Zinc Coated.
 - b. C80.4 Fittings for Rigid Metal Conduit.
 2. Federal Specifications (FS):
 - a. W-C-58C Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron.
 - b. W-C-1094 Conduit and Conduit Fittings Plastic, Rigid.
 - c. WW-C-566C Flexible Metal Conduit.
 - d. WW-C-581D Coatings on Steel Conduit
 - e. National Electrical Manufacturers Association (NEMA):
 - f. RN1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Electrical metallic Tubing.

- g. TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
 - h. TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 - i. NEMA VE 1 - Metal Cable Tray Systems.
 - j. NEMA VE 2 - Metal Cable Tray Installation Guidelines.
3. American Society for Testing and Materials International (ASTM)
- a. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.
 - c. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
4. Underwriters Laboratories Inc. (UL):
- a. 514 B Fittings for Conduit and Outlet Boxes.
 - b. 651 Schedule 40 and 80 Rigid PVC Conduit.
 - c. 651A Type EB and A Rigid PVC Conduit and HDPE Conduit.
 - d. 1666 Standard for Riser Application for Optical Fiber Raceway.
5. National Fire Protection Association (NFPA) ANSI/NFPA 70 National Electrical Code (NEC).
6. ANSI/TIA-569-D-1, Telecommunications Pathways and Spaces
7. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual (TDMM).
8. Local, county, state and federal regulations and codes in effect as of date of purchase.
9. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be
10. Indicate in the proposal the components that may be of foreign manufacture, if any, and the country of origin.

1.3 SUBMITTALS

- A. The Cable Contractor shall perform no portion of the work requiring submittal and review of record drawings, shop drawings, product data, or samples until the respective submittal has been approved by the Owner. Such work shall be in accordance with approved submittals.
- B. Qualifications: The Cable Contractor shall submit qualification data sheets for firms and persons as specified in the "Quality Assurance" article of this specification to demonstrate their capabilities and experience.
- C. Proposed product data sheets: The Cable Contractor shall submit catalog cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection. Identify applicable specification section reference for each product.
- D. Coordination Drawings: The Cable Contractor shall submit coordination drawings showing coordination between communications pathways and other trades.
- E. Record Drawings: Furnish CAD drawings of completed work including cable ID numbers following the Owner's labeling standards. Submit in hardcopy (two full size and two half size) and electronic formats.

1.4 QUALITY ASSURANCE

A. Cable Contractor Qualifications:

1. The Cable Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
2. All work shall be supervised on-site by a BICSI Registered Communications Distribution Designer (RCDD). Must demonstrate knowledge and compliance with all BICSI, TIA, UL, and NEC standards and codes. Cable Contractor shall submit proof of RCDD designation.

B. Provided products shall meet the following requirements: Items of the same classification shall be identical. This requirement includes equipment, assemblies, parts, and components.

C. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

1.5 WARRANTY

A. General Warranty: Refer to General and Special Provisions Document for warranty requirements.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

1.7 DELIVERY AND STORAGE

A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.

B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.

C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.

1.8 COORDINATION

- A. Field coordinate installation of conduit and cable tray with other trades to ensure clearance requirements are met.
- B. Coordinate with all contractors providing equipment outside the scope of this contract.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Definition:
 - 1. For the purpose of this document, the term "Telecommunication Pathways" defines a portion of the communication infrastructure. Telecommunication Pathways include products provided for the routing, segregation and support of telecommunication cabling both inside and outside of facilities.
- B. Primary Industry Standard Requirements for Telecommunication Pathways:
 - 1. Comply with ANSI/TIA-569-D-1

2.2 LADDER RACK

- A. Ladder Rack is to be constructed of steel or brushed aluminum, at least 24 wide and at least 2" deep
 - 1. Manufacture: CPI # 11252-724 or Belden BLRS250-24B
- B. Ladder Rack must be installed with the proper mounting hardware to securely fasten the Ladder Rack to the walls and secured above Rack/Cabinets with pencils rod to deck above.
- C. Cable Tray Supports:
 - 1. Shall be placed so that the support spans do not exceed maximum span per manufacture and NEC load rating. Supports shall be constructed from 12 gauge steel formed shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware, Unistrut or equal.
 - 2. Trapeze hanger's supports shall be supported by 1/2inch (minimum) diameter rods. Cable trays installed adjacent to walls shall be supported on wall mounted brackets. Support shall be loading condition with a safety factor of 3. Pencil rod to be secured to of the Floor-Mounted Racks.
 - 3. Butt-Splice Kit.
 - a. Junction-Splice Kit.
 - b. Heavy-Duty Butt-Splice Kit.
 - c. Heavy-Duty Junction-Splice Kit.
 - d. Adjustable Junction-Splice Kit.

- e. Runway-Splice Kit.
- f. Butt Swivel Splice Kit.
- g. Junction Swivel Splice Kit.
- h. Vertical Swivel Splice Kit.

- D. Accessories provided shall be manufacturer approved and furnished as required for a complete system as defined by the manufacturer to protect, support, bond, ground and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.

2.3 CABLE BASKET

- A. Cable tray shall be the primary pathway for cable distribution from MDF/IDF's to work outlets:
- 1. Comply with ANSI/TIA-569-D-1.
 - 2. Cable tray shall be 12" x 4" to accommodate known cable load and provide for 100% expansion.
 - 3. Cable tray shall be attached directly to the building structure and shall not be supported by any other building systems such as electrical conduits, HVAC duct work, and plumbing or sprinkler pipe.
 - 4. Comply with the requirements of all related NEMA, ASTM and BICSI standards.

2.4 J-HOOKS

- A. J-Hooks shall be the secondary pathway for cable distribution from TRs to work outlets:
- 1. Comply with ANSI/TIA-569-D-1.
 - 2. J-Hooks shall be sized to accommodate known cable load and provide for 100% expansion.
 - 3. J-Hooks shall be attached directly to the building structure and shall not be supported by any other building systems such as electrical conduits, HVAC duct work, and plumbing or sprinkler pipe.
 - 4. Comply with the requirements of all related NEMA, ASTM and BICSI standards.

2.5 CONDUIT SYSTEMS

- A. Conduit pathways shall be provided by the electrical contractor as complete Conduit systems including:
- 1. Conduit with pull strings.
 - 2. Pull box / Junction box assemblies.
 - 3. Mounting / attachment hardware.
 - 4. Labeling.
 - 5. Grounding.
- B. Conduit Fill Calculations.

1. Calculate and provide conduit systems with sizing and quantities to assure conduit wire/cable fill does not exceed pulling tensions, rush limits and performance properties of cables installed.

C. Conduit Trade Sizes

1. Typical conduit trade sizes used in Inside Plant Telecommunication Pathways are:
 - a. Trade Size ½ Inch EMT.
 - b. Trade Size 1 Inch EMT (Minimum Conduit size without written exception by OAT Engineer).
 - c. Trade Size 1 ½ Inch EMT.
 - d. Trade Size 2 Inch EMT.
 - e. Trade Size 3 Inch EMT.
 - f. Trade Size 4 Inch EMT.
 - g. Various trade size "Flex" conduit (typically limited to 6 feet in length).

2.6 FIRESTOPPING

- A. Fire stopping shall be provided for Telecommunication Pathways at penetration areas for fire rated walls and floors. Fire stopping shall meet or exceed the hour rating of wall or floor penetrated by the Telecommunication Pathway.
 1. Fire stopping shall comply with latest release of NEC NFPA 70.
 2. Fire stopping products and applications shall provide containment of smoke, fumes and flame with performance in accordance with ASTM E814-00 and UL 1479.
 3. Local Authority Having Jurisdiction -Building Code Requirements.
- B. Types of Fire stopping hardware and materials include:
 1. Mechanical Fire stopping Products Conduit Sleeves
 - a. Conduit Sleeves.
 - b. Cable Tray Penetrations.
 - c. Penetration Frame Products.
 2. Non-Mechanical Fire stopping Products:
 - a. Putties.
 - b. Caulks.
 - c. Cementitious / Foams / Intumescent Materials.
 - d. Prefabricated Pillows, Blocks and Blankets.
 3. Fire stopping products shall be installed per manufacturer's practices.
 4. Manufactures include:
 - a. Specified Technologies Inc. (STI) SpecSeal
 - b. 3M Products.
 - c. CSD Sealing Systems.
 - d. Approved Equal.

2.7 GROUNDING

- A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.
- B. Telecommunications Main Bus Bar:
 - 1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
 - 2. Ground Bus Bar: Each communication room depicted in the drawings shall be provisioned with a Telecommunications Grounding Busbar (TGB) meeting or exceeding the following requirements:
 - a. Each bar shall be installed with isolated standoff mounts.
 - b. Minimal bar size is 1/2" thick x 2" wide x 10" long.
 - c. The TGB's shall be electroplated and pre-drilled for connector attachment to 6 AWG ground cables.
 - d. Holes spaced 1-1/8 inches apart.
- C. A #6 AWG stranded copper wire cable shall be extended between Telecommunication Room (TR) Busbars (TGB) and the Telecommunications Main Grounding Busbar (TMGB) (located in MDF) via conduit and cable tray systems as shown on the drawings.
- D. Ground conductor shall be provided, installed and utilized for equipment, termination, cable tray, equipment rack and computer equipment grounding, including telephone systems.
- E. All grounding material and work shall comply with the National Electric Code (NEC Chapter 8), Local and State regulations as well as ANSI-J/STD-607-C.
- F. Coordinate with the electrical power trades for grounding wiring interface to an approved connection to the building electrical power service panel ground source. Provide #6 AWG stranded copper bonding conductor extending from the electrical ground source to the Telecommunication Main Grounding Busbar (TMGB) located in the MDF.
- G. Provide ground cable #6 AWG stranded copper bonding conductor installed from the TMGB to each of the TR's as depicted in the project drawings ground wiring riser diagram.
- H. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line P/N: SB-477 or equal.

2.8 IDENTIFICATION PRODUCTS

- A. Comply with ANSI/TIA-606-C and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.9 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers that may be incorporated in the work, include, but are not limited to the following:
1. PVC Rigid Conduit:
 - a. Carlon.
 - b. Robroy Industries, Inc.
 - c. Cantex.
 - d. Or equal.
 2. Conduit Fittings and Bodies:
 - a. Crouse-Hinds, Appleton Electric.
 - b. Killark Electric Manufacturing Company.
 - c. O-Z/Gedney.
 - d. Or equal
 3. J-HOOKS:
 - a. Erico/Caddy.
 - b. Or equal.
 4. Measured pull tape - pull tape printed with sequential footage markings for accurate measurements:
 - a. Fibertek.
 - b. Condux International.
 - c. Or equal.
 5. Cable Basket / Ladder Rack
 - a. Belden Ladder Rack.
 - b. Cablo-Fil.
 - c. CPI.
 - d. Or equal.

2.10 MATERIALS

- A. Conduits
1. All conduits, fittings, junction and pull boxes shall be UL rated.
 2. All conduits, fittings, junction and pull boxes shall comply with the NEC.
- B. Non-metallic conduits are not permitted in above ground installations. Conversion fittings are required for non-metallic (below ground) to metallic (above ground) transitions. Exceptions will be granted to accommodate the transition from outside plant to inside plant to comply with code requirements
- C. Measured Pull Tape
1. Pre-lubricated, woven polyester, low friction, and high abrasion resistant yarn
 2. Minimum average tensile strength shall be 1250 lbs. for 1%-inch and smaller conduits and inner duct.
 3. Minimum average tensile strength shall be 1800 lbs. for conduits larger than 1% inch.

D. Pull Boxes, Junction Boxes and Gutters

1. All junction boxes, gutters and pull boxes shall comply with NEC Article 314.
2. All junction boxes, gutters and pull boxes shall meet the following minimum material requirements:
 - a. 16-gauge steel or heavier.
 - b. Seams shall be continuously welded and grounded smooth.
 - c. External screws and clamps.
 - d. External mounting feet (where possible).
 - e. Oil-resistant gasket and adhesive.
 - f. ANSI 61 gray polyester powder coating inside and out over phosphatized surface.
 - g. UL 50 type 12.
3. All junction boxes, gutters and pull boxes shall be provided with bushings for conduits and/or cabling.
4. All junction boxes, gutters and pull boxes shall be securely installed.
5. All junction boxes, gutters and pull box sizes for single and multiple conduit runs shall comply with BICSI TDMM.

E. CABLE BASKET, CABLE TRAY and LADDER RACK

1. Rated for use with Category 6a cable
2. Sized for support of quantity of cable installed at each location
3. Metallic and/or plenum rated.

F. J-HOOKS

1. Rated for use with Category 6a cable
2. Installed as shown in drawings
3. Metallic and/or plenum rated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cable Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.
- B. Verify conduit system is properly sized for cables (minimum one inch, unless otherwise noted in Drawings).
- C. Verify general conduit route following Drawings.
- D. Verify substrates to which work is connected and determine detail requirements for proper support.
- E. Verify proper location and type of rough-in for conduit terminations.

3.2 INSTALLATION

- A. Coordinate locations with other trades prior to installation.
- B. Install work following drawings, manufacturer's instructions and approved submittal data.
- C. Installation plans and requests for information (RFIs) shall be reviewed by Cable Contractor's on-site RCDD.
- D. All work shall be supervised and reviewed by Cable Contractor's on-site RCDD.
- E. Locations and Types:
 - 1. J-HOOKS
 - a. Install J-Hooks directly to building structure. Hooks may not be supported by any other building system - e.g. HVAC ducts, electrical conduits, plumbing or ceiling supports.
 - b. J-Hooks shall be installed every 48".
 - c. J-Hooks must be install straight level & plumb.
 - d. Cables shall be neatly bundled and secured to hooks using Velcro or Velcro type straps or fasteners.
 - e. Cable Contractor's RCDD supervisor shall coordinate with drawings of other disciplines to determine availability of space for installation.
 - 2. CABLE TRAY/ LADDER RACK
 - a. Install cable tray in telecomm closets as depicted on drawings
 - b. Position, elevation and routing of cable tray shall be coordinated with GC to ensure there is no conflict with equip-net furnished and installed by any other contractor on site (e.g. HVAC, Electrical, Plumbing etc.)
 - c. Cable tray shall be secured directly to building structure and not supported by any other equipment or service element (e.g. ceiling grid, black iron, HVAC supports etc.)
 - d. Ladder within the telecommunications rooms (MDF, IDF) may be supported to the above the equipment racks within these rooms.
 - e. Support system shall be straight, level and plumb and show no signs of sagging or drooping at any point.
 - f. Cables in these trays shall be neatly bundled and secured using Velcro straps ONLY
 - g. All tray and ladder rack shall be grounded according to NEMA, BICSI and local jurisdiction requirements
 - h. Cable Contractor's RCDD supervisor shall coordinate with drawings of other disciplines to determine availability of space for installation.
 - 3. CABLE BASKET
 - a. Install cable basket in hallway ceilings as depicted on attached drawings telecomm closets as depicted on drawings
 - b. Position, elevation and routing of cable basket shall be coordinated with GC to ensure there is no conflict with equipment furnished and installed by any other contractor on site (e.g. HVAC, Electrical, Plumbing etc.)

- c. Cable basket shall be secured directly to building structure and not supported by any other equipment or service element (e.g. ceiling grid, black iron, HVAC supports etc.)
- d. Support system shall be straight, level and plumb and show no signs of sagging or drooping at any point.
- e. Cables in these baskets shall be neatly bundled and secured using Velcro straps ONLY
- f. All Cable basket shall be grounded according to NEMA, BICSI and local jurisdiction requirements
- g. Cable Contractor's RCDD supervisor shall coordinate with drawings of other disciplines to determine availability of space for installation.

F. Design Considerations:

- 1. Conduit fill shall comply with ANSI/TIA -569-D.
- 2. The minimum bend radius is six times the conduit inside diameter (ID) for a two inch conduit or less.
- 3. The minimum bend radius is 10 times the conduit ID for a conduit greater than two inches.
- 4. Below grade conduit shall extend three inches above finished floor (AFF) with a bushing.
- 5. Ceiling conduit or sleeves shall extend six inches below finished ceiling with a bushing.
- 6. All stubbed conduit ends shall be provided with a ground bushing.
- 7. All conduit penetrations shall comply with all applicable fire codes. All conduit penetrations in fire-rated walls or floors shall be sealed and fire proofed to at least the rating of the penetration area.
- 8. Conduits shall be routed in the most direct route, with the fewest number of bends possible.
- 9. There shall be no continuous conduit sections longer than 100 feet. For runs that total more than 100 feet, insert junction or pull boxes (or gutters if appropriate) so that no continuous run between pull boxes is greater than 100 feet.
- 10. There shall be no more than two 90-degree bends (180 degrees total) between conduit pull boxes.
- 11. Changes in direction shall be accomplished with sweeping bends observing minimum bend radius requirements above. Do not use pull boxes for direction changes unless specifically designated otherwise in the Drawings.
- 12. Unless otherwise noted in the Drawings, conduits entering pull boxes shall be aligned with exiting conduits.

- G. Identification: Refer to Section 270553 Identification for Communications Systems for labeling requirements.

3.3 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials and debris from each area where Work has been completed unless designated for storage.

3.4 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and the Owner is satisfied that all work has been completed in accordance with contract documents; the Owner will notify Cable Contractor in writing of formal acceptance of the system.
- B. Acceptance shall be subject to completion of all work and submittal and approval of full documentation as described above.

END OF SECTION 270528

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes labeling and identification standards for:
 - 1. Horizontal and backbone cabling and termination hardware
 - 2. Conduits and pathways
 - 3. Equipment cabinets, racks, frames and enclosures
- B. As-builts shall contain matching label information

1.2 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts:
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 - 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- D. References:
 - 1. ANSI/TIA -606-C Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - 2. International Standards Organization/International Electromechanical Commission (ISO/IEC) DIS11801, January 6, 1994
 - 3. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM)
 - 4. Local, county, state and federal regulations and codes in effect as of date of purchase.

5. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be indicated in the proposal the components that may be of foreign manufacture, if any, and the country of origin

1.3 SUBMITTALS

A. Product Data:

1. The Contractor shall submit catalog cut-sheets that include manufacturer, trade name, and complete model number for each product specified.
2. Model number shall be handwritten and/or highlighted to indicate exact selection. Identify applicable specification section reference for each product.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

1.4 QUALITY ASSURANCE

- A. Provided products shall meet the following requirements: Items of the same classification shall be identical. This requirement includes equipment, assemblies, parts, and components.
- B. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers that may be incorporated in the work, include, but are not limited to the following:
- B. Labels and Labeling System
 1. Basis of Design: Brady
 2. Acceptable substitutes: Dymo, Belden or submitted and Approved equal

2.2 GENERAL REQUIREMENTS

- A. All telecommunication components, areas, and cables shall be labeled, including but not limited to:
 1. Fiber cables.
 2. Metallic cable.

3. Ground points.
 4. Cross-connect fields.
 5. Exterior enclosures.
 6. Conduit ends (pathways).
 7. Pull boxes and junction boxes.
 8. Equipment racks and cabinets.
 9. Fiber patch panels
 10. Maintenance holes.
 11. Cables in maintenance holes and pull boxes.
 12. Patch cables/jumpers.
- B. Pathways are defined but not limited to; any conduit, innerduct, underground duct bank, wiring troughs, pull boxes, and any wiring systems used to enclose cabling of any type.
- C. All label material shall be suitable for intended usage and environment, meeting the legibility, defacement and general exposure requirements listed in UL 969 for indoor and outdoor use. Where insert labels are used, the insert label shall be covered with clear cover and securely held in place.
- D. Interior labeling: printer shall be of the thermal transfer type capable of printing self-laminating labels of various size up to and including 1.5"by 1.5" printable area with a 4.5" self-laminating tail. No non-self-laminating labels shall be approved.
- E. All labels shall be permanent, i.e. will not fade, peel, or deteriorate due to environment or time.
- F. Handwritten labels are not acceptable.

2.3 CONDUITS AND PATHWAYS

- A. Conduits: General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive, trade name, "Mondo Bondo" (Brady). Label size shall be appropriate for the conduit size. Font size shall be easily visible from the finished floor.
- B. Innerduct: Polyethylene general-purpose tagging material
1. Brady part number PTL-12- 109 (.75 X 3.00) used with an R4310 ribbon. This tag shall be attached using tie wraps.
- C. Junction boxes (larger than four-inch x four-inch): General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive, trade name, "Mondo Bondo", Brady part number PTL-43-483 (1.90 X continuous) used with an R6010 ribbon. Font size shall be easily visible from the finished floor.

- D. Junction boxes (four-inch x four-inch): General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive, trade name, "Mondo Bondo"
 - 1. Brady part number PTL-42-483 (1.00 X continuous) used with an R6010 ribbon.

2.4 BACKBONE AND HORIZONTAL CABLE AND TERMINATIONS

- A. Fiber termination hardware (cover): General purpose label designed for powdered coated surfaces, trade name, "Mondo Bondo"
 - 1. Brady part number PTL-42-483 (1.00 X continuous) used with an R6010 ribbon.
- B. Fiber termination hardware (designation strip): Thermal transfer printable label with a permanent acrylic adhesive
 - 1. Brady part number PTL-10-423 (.75 X .25) used with an R6010 ribbon.
- C. Patch panels: Gloss white film with a permanent acrylic based adhesive
 - 1. Brady part number PTL-39-422 (.375 X .60) used with an R6010 ribbon.
- D. Inside and outside plant fiber cables: Permanent acrylic adhesive, self-laminating vinyl wire and cable identification
 - 1. Brady part number PTL-33-427 (1.50 X 4.00 X 1.00) used with an R4310 ribbon.

2.5 EQUIPMENT RACKS AND CABINETS

- A. General purpose label designed for powdered coated surfaces.
- B. Basis of Design: Trade name, "Mondo Bondo",
 - 1. Brady part number PTL-42-483 (1.00 X continuous) used with an R6010 ribbon.

PART 3 - EXECUTION

3.1 GENERAL

- A. Labeling format shall be as shown in Telecommunications Drawings Set.

3.2 CONDUITS AND JUNCTION/PULL BOXES

- A. All conduits, innerduct, junction boxes, gutters and pull boxes shall be labeled.

- B. Conduits shall be labeled with the word "communications" and the conduit's origination room number and destination room number. Permanent room identifiers shall be used.
- C. Label conduit every 50 feet, at each wall and floor penetration and at each conduit termination, such as outlet boxes, pull boxes, and junction boxes, or as otherwise specified in other Sections.
- D. Junction boxes, gutters and pull boxes shall be labeled with identification name or number as determined by Contractor and submitted for approval.
- E. Labels on conduits, junction boxes, gutters and pull boxes shall be machine-generated and easily visible from the finished floor.

3.3 FIBER TERMINATIONS

- A. Label cable terminations on designation strips.
- B. Label all cable at each terminating point.
- C. Labels shall be self-adhesive and machine generated.
- D. Handwritten labels are not acceptable
- E. Cable identification numbers shall not be duplicated.
- F. Three copies of a cable record document containing the cable information required on the cable label shall be delivered to the GOAA Telecommunications Department.

3.4 EQUIPMENT RACKS AND CABINETS

- A. All racks and cabinets shall be properly labeled with permanent typewritten labels, easily visible from finished floor.
- B. Label as indicated in Drawings.

3.5 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

3.6 ACCEPTANCE

- A. Once all work has been completed and the Owner is satisfied that all work has been completed in accordance with contract documents, the Owner will notify Contractor in writing of formal acceptance of the system.
- B. Acceptance shall be subject to completion of all work and submittal and approval of full documentation as described above.

END OF SECTION 270553

SECTION 270813 – TESTING COPPER CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. The work covered by this section of the Specifications includes all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work of this section shall include, but is not limited to, the following:

1. Cable testing for copper cables.
2. Providing testing results in accordance with the strictest manufacturer written recommendations.

1.2 QUALITY ASSURANCE

A. Refer to Section 270000 for general details.

1.3 CODES, STANDARDS AND GUIDELINES

A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Section 270000.

1.4 SUBMITTALS

A. Refer to Section 270000 for general details.

B. Submit Manufacturer's Cut Sheets for the following:

1. Any products not specifically listed in the PRODUCTS section shall require a submittal of the manufacturer's cut sheets.

C. List of test equipment to be used.

D. Sample of test data to be provided to the campus representative at the completion of testing.

D. Identity and qualifications of Contractor's personnel who will perform the testing.

E. Submit the proposed schedule for performing testing at least 2 weeks prior to the start of testing.

1.5 IDENTIFICATION

A. Refer to Section 270553 for general details.

1.6 WARRANTY

- A. Refer to Section 27 00 00 for general details.

PART 2 – PRODUCTS

2.1 CATEGORY 5 EUTP CABLE TESTER

- A. Testing for all cables 25 pair or larger are to use a tester that tests 25 pair at a time.
- B. The field tester must meet the requirements of ANSI/TIA/EIA-568.
- C. Make and model at Contractor's discretion.

2.2 CATEGORY 6 AUTP CABLE TESTER

- A. The field tester must be a Level IV or greater.
- B. The field tester must meet the requirements of ANSI/TIA/EIA-568-B.2, Addendum 1
- C. Tester must output test results with Fluke's LinkWare reporting software.
- D. Make and model at Contractor's discretion.

2.3 MULTIMETER

- A. Make and model at Contractor's discretion.

PART 3 – EXECUTION

3.1 GENERAL

- A. The Contractor shall test, as described below, all metallic cables installed under these specifications.
- B. Visually inspect all cables, cable reels, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
- C. Where post-manufacturer test data has been provided by the manufacturer on the reel or shipping carton: submit copies to the campus representative prior to installing cables.
- D. Test fully completed systems only. Piecemeal testing is not acceptable.
- E. Testing shall not be performed until after all hardware is installed and attached, and all labeling and identification has been completed.

- F. Any cable that does not pass all required testing shall be removed, replaced, and retested.
- G. Remove and replace any defective cables from pathways system. Do not abandon cables in place.
- H. The telecommunications representative reserves the right to observe all portions of the testing process.
- I. The telecommunications representative further reserves the right to conduct "Proof of performance testing", using Contractor equipment and labor, a random re-test of up to ten percent (10%) of the cable plant to confirm documented test results.
- J. Perform all tests as required by the manufacturer in support of the structured cabling system warranty.

3.1 GROUNDING & BONDING

- A. All grounding and bonding is to be complete before any system testing is to be attempted.

3.2 TESTING

- A. All test results are to be defined as acceptable / unacceptable by the requirements of ANSI/TIA/EIA-568 B.2.

- B. Copper Cables - General Requirements

- 1. After terminating and splicing the cables. Test all cable pairs for:
 - a. Continuity to the remote end.
 - b. Shorts between any 2 or more conductors or ground
 - c. Transposed pairs
 - d. Reversed Pairs
 - e. Split Pairs
 - f. Crossed Pairs
 - g. Wire map.
 - h. Length.
 - i. Shield Continuity (If Shielded)
 - j. Continuity to Grounding (If Shielded)
- 2. Using a multimeter, test continuity to ground (TGB or TMGB) for a maximum resistance of 1Ω, see section 27-05-26 for additional detail.

- C. Indoor Riser or OSP Copper Cable
 - 1. After terminating and splicing the cables. Test all cable pairs for:
 - a. DC Loop Resistance for any 2 conductors in the cable
- D. Category 6 Copper Station Cables:
 - 1. Contractor is to perform a three connector permanent link test.
 - 2. After terminating both ends of all 4-pair cables, but before any cross-connects are installed, test these cables for the following:
 - a. Return Loss
 - b. Insertion Loss
 - c. Attenuation
 - d. NEXT (near-end crosstalk)
 - e. PSNEXT (power sum near-end crosstalk)
 - f. FEXT (far end crosstalk)
 - g. ACR-F (attenuation to crosstalk ratio)
 - h. PSACR-F (power sum attenuation to crosstalk ratio)
 - i. Propagation delay
 - j. Delay skew

3.3 ACCEPTANCE

- A. All test results for Cat 3 cable are to be documented and submitted in Microsoft Excel or .csv format to the campus telecommunications representative within five (5) working days of test completion.
- B. All test results for Cat 6 cable are to be documented and submitted in Fluke LinkWare format to the campus telecommunications representative within five (5) working days of test completion.
- C. Test result shall be recorded per cable and identical copies placed on three removable media devices (CD or DVD) for delivery to the campus project manager and campus telecommunications representative.
- D. Each test report shall contain the following general information:

1. Date of Preparation
2. Date of Test
3. Project Name
4. Contractor's Name
5. Media Type
6. Make, Model and Serial Number of test equipment used
7. Date of Last Calibration
8. Names of Test Crew.

E. In addition to the results of the specific tests specified, reports shall also include:

1. Cable Number
2. Cable Type
3. Pair or Conductor Count
4. Individual Pair or Conductor Numbers,
5. Results of Each Test for Each Pair or Conductor
6. Total Number of Serviceable Pairs or Conductors in Cable.
7. Ground Resistance Measurements

F. Once the testing has been completed and the telecommunications representative is satisfied that all work is in accordance with the Contract Documents, the representative will notify the Contractor and/or project manager in writing or via email.

END OF SECTION 270813

SECTION 27100 STRUCTURED CABLING

PART 1 - GENERAL

1.1 REFERENCES

- A. All work shall be performed in accordance with the following Codes and industry Standards, unless noted otherwise:
1. NFPA 70 - National Electrical Code, current version adopted by local or State AHJ.
 2. ANSI/TIA-568.0-D Generic Telecommunications Cabling for Customer Premises
 3. ANSI/TIA-569-D-1, Telecommunications Pathways and Spaces.
 4. ANSI/TIA-606-C, Administration Standard for Commercial Telecommunications Infrastructure.
 5. ANSI/TIA-607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 6. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings, pertaining to communication systems.

1.2 WARRANTY

- A. The Cable Contractor must be an approved Certified Installer. The Cable Contractor is responsible for workmanship and installation practices in accordance with the Manufacture Certified Installer or Partner Alliance (PA) program offering a 25 year warranty issued to the end user. The Cable Contractor shall have 30% of their technicians trained on fiber and copper installations and testing; they also shall have at least 1 project manager successfully complete a Manufacture 2-Day Management Certification class. Painting or paint overspray will void the warranty. The Telecommunications Contractor shall ensure that the General Contractor and Painting Contractor acknowledge that painting of or over spray any single or group of 4 pair horizontal telecommunications Category 5e or Category 6 cable is not allowed. Any painted or over sprayed cable(s) shall be replaced at the painting contractor's expense. Painted Cable will not be covered as part of an extended warranty. Painted cable in addition to obscuring the print legend may act as an accelerant or create an additional smoke hazard in the event of a fire and as such this is considered a life safety issue.

1.3 SUMMARY

- A. This Section includes general requirements specifically applicable to Division 27.
1. Work Specifically Excluded from Project:
 2. Materials provided by the owner as identified in the Contract Documents.

- B. The Cable Contractor shall be responsible for:
1. Providing all additional materials, and the necessary labor and services required to ensure all components of the system are completely installed in accordance with the intent of the Contract Documents.
 2. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
 3. Coordinating the details of facility equipment and construction for all specification divisions that affect the work covered under this Division.
 4. Coordinating all activities with the overall construction schedule.
 5. Developing bill of materials, perform material management and efficient use of the materials whether they are issued by the Cable Contractor, the owner or purchased by the Cable Contractor.
 6. Ensure materials in excess of those required to complete the project are kept in their original condition and packaging for restocking.
 7. Ensure project is properly registered for a warranty.
 8. Furnish and install fire stopping for all fire rated penetrations or as required by AHJ.
 9. Ensure entire system is installed in compliance with all applicable Federal, State and local codes and standards. The more stringent codes and standard shall take precedence.
- C. Intent of Drawings:
1. Communications plan drawings show only general locations of equipment, devices, raceways, cable trays, boxes, etc. All dimensioned locations and elevations are approximate. The Cable Contractor is responsible for the field coordination of communications work with the other trades prior to beginning work.
 2. The Cable Contractor shall be responsible for the proper placement and routing of equipment, cable, raceways, cable tray, and related components; according to the Contract Documents and subject to prior review by Cable Contractor.
 3. Refer all conflicts between Contract Documents to Cable Contractor for resolution.

1.4 DEFINITIONS

- A. Active Equipment: Electronic equipment used to develop various WAN and LAN services.
- B. Backbone: Collective term sometimes used to describe the campus and vertical distribution subsystem facilities and media interconnecting service entrances, communications rooms, and communications cabinets.
- C. Bonding: Permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed on it.
- D. Main Distribution Frame (MDF): Room in each building used to distribute communications services to Intermediate Distribution Frame (IDF) in the same building. Typically, the MDF contains passive equipment used for electrical protection (protectors) and building cross connect, and active network equipment used for LANs. The IDF may also serve the function of an IDF.

- E. Cabinet: Freestanding, floor-mounted modular enclosure designed to house and protect rack - mounted electronic equipment.
- F. Cable Tray: Vertical or horizontal open supports usually made of aluminum or steel that is fastened to a building ceiling or wall. Cables are laid in and fastened to the trays. A cable tray is not a raceway.
- G. Campus: Grounds and buildings of a multi-building premises environment.
- H. Channel: The end-to-end transmission path between two points at which application specific equipment is connected; may include one or more links, cross-connect jumper and/or patch cords, and work area station cords. Does not include connection to active equipment.
- I. Communications Equipment Room -See IDF Drawings.
- J. Cross-Connect: Equipment used to terminate and tie together communications circuits.
- K. Cross-Connect Jumper: A cluster of twisted-pair conductors without connectors used to establish a circuit by linking two cross-connect termination points.
- L. Fiber Optic Distribution Unit (FDU): Cabinet with terminating equipment used to develop fiber optic cross-connect facilities.
- M. Grounding: A conducting connection to earth, or to some conducting body that serves in place of earth.
- N. Hinged Cover Enclosure: Wall-mounted box with a hinged cover that is used to house and protect electrical devices.
- O. Horizontal: Pathway facilities and media connecting IDF to Telecommunications Outlets (TO).
- P. Jack: Receptacle used in conjunction with a plug to make electrical contact between communications circuits, e.g., eight-position/eight-contact modular jacks.
- Q. Link: A transmission path between two points, not including terminal equipment, work area cables, and equipment cables; one continuous section of conductors or fiber, including the connecting hardware at each end.
- R. Local Area Network (LAN): Data transmission facility connecting a number of communicating devices, e.g., serial data, Ethernet, token ring, etc. Typically, the network is limited to a single site.
- S. Main Equipment Room (MER): The room used to distribute communication services to all MDF's on the premises, and to interconnect premises services with the telephone companies.
- T. Media: Twisted-pair, fiber optic cable or cables used to provide signal transmission paths.
- U. Mounting Frame: Rectangular steel framework which can be floor or wall mounted to support wiring blocks, patch panels, and other communications equipment.
- V. Passive Equipment: Non-electronic hardware and apparatus, e.g., equipment racks, cable trays, electrical protection, wiring blocks, fiber optic termination hardware, etc.

- W. Patch Cords: A length of wire or fiber cable with connectors on one or both ends used to join communications circuits at a cross-connect.
- X. Patch Panel: System of terminal blocks or connectors used with patch cords that facilitate administration of cross-connect fields.
- Y. Pathway: Facility for the placement of communications cable. A pathway facility can be composed of several components including conduit, wireway, cable tray, surface raceway, underfloor systems, raised floor, ceiling support wires, etc.
- Z. Protectors: Electrical protection devices used to limit foreign voltages on metallic communications circuits.
- AA. Raceway: An enclosed channel designed expressly for holding wires or cables; may be of metal or insulating material. The term includes conduit, tubing, wire way, underfloor raceway, and surface raceway; does not include cable tray.
- BB. Racks: An open, freestanding, floor-mounted structure, typically made of aluminum or steel, used to mount equipment; usually referred to as an equipment rack.
- CC. Telecommunication Outlet (TO): Connecting device mounted in a work area used to terminate horizontal cable and interconnect cabling with station equipment.
- DD. IDF: Distributes communications services to users within a serving zone and interconnects with the BER. Typically, the TER contains passive equipment used for cross connect and active network equipment used for LANs. TR is sometimes referred to as the communications equipment room.
- EE. Wide Area Network (WAN): Active communications transmission facilities extending beyond the premises.
- FF. Wiring Block: Punch down terminating equipment used to develop twisted-pair cross connect facilities.

1.5 SYSTEM DESCRIPTION

- A. The owner will implement a comprehensive integrated communications distribution system, as described in paragraph B below, to provide wiring infrastructure which may be used to support one or more of the following services and systems:
 - 1. Data telecommunications.
 - 2. Wireless systems.
 - 3. Facilities management systems.
 - 4. Mass Notification.
 - 5. Paging.
 - 6. Life Safety.
- B. The communications distribution system consists of the following major subsystems, as specified elsewhere:

1. Intra-Building Backbone: The inter-building subsystem refers to all twisted pair and fiber optic backbone communications cabling connecting the MDF to IDFs in separate buildings.
 2. Communication Rooms: The communications room contains the distribution subsystem comprised of the passive components used to terminate cabling subsystems and distribute communications services. This subsystem includes installations in the MDR (MDF), in IDR (IDF) and Telecommunications Enclosures (TEs). Constructed as specified in Section 271100.
 3. Horizontal Distribution: The horizontal distribution subsystem refers to all intra-building twisted-pair and fiber optic communications cabling connecting IDF's to telecommunication outlets (TOs) located at individual work areas. Constructed as specified in Section 271500.
 4. Work Area Distribution Subsystem: Patch cords, adapters, and devices located between the TO and station equipment. Constructed as specified in Section 271600.
- C. The communications distribution system is based on a combination of the following communications transmission technologies:
1. 100-ohm 4-pair unshielded twisted-pair cable 100MHz (CAT5e).
 2. 100-ohm 4-pair unshielded twisted-pair cable 500MHz (CAT6a).
 3. 8-position telecommunications jacks.
 4. 8-position telecommunications patch panels (CAT5e, CAT6 and CAT6a).
 5. Insulation displacement connector (IDC) type field terminated wiring blocks.
 6. Factory Terminated copper patch cords.
- D. The work locations and limits of work are shown on the drawings.

1.6 DESIGN CRITERIA

- A. Compliance by the Cable Contractor with the provisions of this specification does not relieve him of the responsibilities of furnishing materials and equipment of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.
- B. The following are incorporated into the design:
1. The location of communication rooms is intended to restrict the maximum horizontal subsystem wiring length (defined as a channel between a telecommunications room cross-connect termination field and a served TO) to 295 feet (90 meters).

1.7 WARRANTY

- A. The Cable Contractor shall provide a manufacturer's warranty on the horizontal systems as specified in Section 271500.
- B. In addition to the standard warranty requirements, the Certified Contractor shall provide the following during the warranty period:
1. Within 24 hours after notification of a defect, the Certified Contractor shall start to make the necessary corrections and inform the appropriate Project Manager of the planned corrective

actions. The Certified Contractor shall follow this initial contact with continuous effort and complete any required corrective work within 15 days after notification.

1.8 QUALIFICATIONS

- A. Communications Pathway Installation: The Cable Contractor shall have 5 years of documented experience installing raceway and cable tray systems for each of the types and system material components specified in the Contract Documents, e.g., underground duct banks, cable tray, etc. In the case of newer technologies that do not have a 3-year history, the Cable Contractor shall have documented experience for at least half of the lifetime of the new technology.
- B. The Cable Contractor selected for this project must be certified by the manufacturer of the products (Panduit/General) adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project.
- C. The Cable Contractor must be an approved Certified Installer for the system bid. The Cable Contractor is responsible for workmanship and installation practices in accordance with the Certified Installer. The certified contractor shall have 30% of their technicians trained on copper & fiber installations and testing; they also shall have at least 1 project manager successfully complete a 2-Day Management Certification class.
- D. Company certificate & letter from manufacturer stating certification is in good standing, shall be included with submittal.
- E. Certified Installer must register project with Manufacture and must provide a warranty on the installation workmanship & testing for a length of twenty-five (25) years.
- F. The Cable Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Cable Contractor shall own and maintain tools and equipment necessary for successful installation and testing of both fiber optic and Category 6A premise distribution systems and have personnel who are adequately trained in the use of such tools and equipment.
- G. A resume of qualification shall be submitted with the Cable Contractor's proposal indicating the following:
 - 1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 - 2. A technical resume of experience for the Cable Contractor's Project Manager and on-site installation supervisor who will be assigned to this project.
 - 3. A list of technical product training attended by the Cable Contractor's personnel that will install the structured cabling system shall be submitted with the response.
 - 4. Any sub-contractors, who will assist the Certified Contractor in performance of this work, shall have the same training and certification as the Certified Contractor.

1.9 SUBMITTALS

A. General:

1. Provide ongoing inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions of same are clearly indicated and non-applicable portions clearly deleted or crossed out.
3. When the specifications include product descriptions, model numbers, part numbers, etc. that have been superseded, changed, or discontinued, the Cable Contractor shall submit a comparable substitution for review by the A/E.

B. Provide all applicable portions of the following information with the Bid:

1. Documentation establishing qualifications to perform installation functions as required in 1.9 above:
2. Statement demonstrating an understanding of project scope and schedule which includes the following information:
 - a. Where (city, office) the project will be staffed.
 - b. Project organizational chart with team names; e.g., project manager, A/Es, principal skilled technicians, and contractors.

C. Provide all applicable portions of the following information within 10 days of award of Subcontract:

1. Project schedule in hard copy. Include, at a minimum, major tasks, milestones, dependencies, staffing, and durations for each task.
2. Cable Contractor shall work with other contractors to merge this schedule into the overall construction schedule.
3. Provide the following information for materials, components, and equipment to be furnished by the Cable Contractor:
 - a. Descriptive literature, manufacturer's specification data sheets, and manuals.
 - b. Individual price and delivery schedules.
 - c. Final Performance testing criteria and data for communications distribution system cabling systems.

1.10 DEFINITION OF ACCEPTANCE

A. System acceptance shall be defined as that point in time when the following requirements have been fulfilled:

1. All submittals and documentation have been submitted, reviewed, and approved.
2. The complete system has successfully completed all testing requirements.
3. All owner staff personnel training programs have been completed.
4. All punch list items have been corrected and accepted.
5. Project registration for warranty by manufacturer.

1.11 PROJECT RECORD DOCUMENTS

- A. A. Provide detailed project record documentation within 30 days after completion of the work.
 - 1. Maintain separate sets of red-lined record drawings for the communications work which show the exact placement and identification of as-built system components.
 - 2. Provide communication pathway record drawings which indicate exact placement and routing for all components, e.g., maintenance holes, hand-holes, conduit, wire-way, cable tray, pull boxes, enclosures, telecommunications outlet boxes, etc.
 - 3. Provide communication room record drawings which indicate exact placement for all components; e.g., conduit, wire-way, cable basket, cable tray, backboards, equipment cabinets, equipment racks, cross-connect equipment, etc.
 - 4. Provide communication wiring and cabling record "As-Built" drawings and schedules which indicate exact placement, routing, and connection details for all components, e.g., twisted-pair and fiber optic cables, splices, cable cross-connect termination locations, enclosures, telecommunications outlets, cross-connect jumpers, patch cords, etc.
 - 5. Provide network schematics when appropriate.

PART 2 - PRODUCTS

2.1 APPROVALS AND SUBSTITUTIONS

- A. The approved telecommunications hardware manufacturers:
 - 1. Belden Connectivity
 - 2. Ortronics/Superior Esseex
 - 3. Leviton/BerkTek
 - 4. Or Equal
- B. If an equal product is to be bid, Cable Contractor must get prior approval from project engineer or client in order to be considered for substitution.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Manufactured products, materials, equipment, and components shall be provided, conditioned, applied, installed, connected, and tested in accordance with the manufacturer's specifications and printed instructions.
- B. The installation of all system components shall be carried out under the direction of qualified personnel. Appearance shall be considered as important as mechanical and electrical efficiency. Workmanship shall meet or exceed industry standards.

3.2 SERVICE CONTINUITY

- A. Manufactured products, materials, equipment, and components shall be provided, conditioned, applied, installed, connected, and tested in accordance with the manufacturer's specifications and printed instructions.
- B. The installation of all system components shall be carried out under the direction of qualified personnel. Appearance shall be considered as important as mechanical and electrical efficiency. Workmanship shall meet or exceed industry standards.

3.3 LAYOUT AND TOLERANCES

- A. Follow as closely as practicable the design shown on the drawings. Make all necessary measurements in the field to verify exact locations and ensure precise location and fit of specified items in accordance with the drawings. Make no substantial alterations without prior approval of Cable Contractor and the A/E.
- B. Perform all work to the lines, grades, and elevations indicated on the drawings. Provide experienced, competent personnel to locate and lay out the work and provide them with suitable tools, equipment, and other materials required to complete layout and measurement work. Use lasers or other approved methods to establish line and grade.

3.4 CONSTRUCTION REVIEW

- A. The A/E and Cable Contractor will review and observe installation work to ensure compliance by the Cable Contractor with requirements of the Contract Documents.
- B. The Cable Contractor shall inspect and test completed communications installations to demonstrate specified performance levels including the following:
 - 1. Furnish all instruments and personnel required for the inspections and tests.
 - 2. Perform tests in the presence of the A/E and Cable Contractor.
 - 3. Demonstrate that the system components operate in accordance with the Contract Documents.
 - 4. All existing data cabling that is to be abandoned must be removed in its entirety and discarded.
 - 5. All unused Data cabling cabinets are to be removed and discarded.
 - 6. All existing data boxes (TO) and wiremold raceways are to be removed and discarded.
 - 7. All electronic equipment in the Data cabinets is to be returned to the district for reuse.
- C. Review, observation, assistance, and actions by the Architect/Engineer (A/E) or Cable Contractor (GC) shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Cable Contractor. The A/E's and GC's review and observation activities shall not relieve the Cable Contractor from the responsibilities of these Contract Documents.

- D. The fact that the A/E, GC or the owner does not make early discovery of faulty or omitted work shall not bar the A/E, GC or the owner from subsequently rejecting this work and insisting that the Cable Contractor make the necessary corrections.
- E. Regardless of when discovery and rejection are made, and regardless of when the Cable Contractor is ordered to correct such work, the Cable Contractor shall have no claim against the A/E, GC or the owner for an increase in the Subcontract price, or for any payment on account of increased cost, damage, or loss.

END OF SECTION 271000

SECTION 271100 – COMMUNICATIONS EQUIPMENT ROOM AND FITTINGS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. Telecommunications Rooms (MDF/IDF) are generally considered to be floor serving facilities. Horizontal Cross-connects link the Horizontal cable and the Backbone Cable together. The Horizontal Cross-connects shall consist of rack or wall mounted wiring blocks or panels for termination of copper cables or rack or wall mount interconnect termination units or fiber management panels/trays for the termination of optical fibers. Cross-connect spaces include the labeling of hardware for providing circuit identification and patch cords or cross-connect wire used for creating circuit connections at the cross-connect.

1.3 SCOPE

- A. This section includes the minimum requirements for equipment, termination hardware and cable installations in communication equipment rooms.
- B. The telecommunications room shall be equipped to contain telecommunications equipment, cable terminations, and associated cross-connects.
- C. Minimum composition requirements and installation methods for the following:
 - 1. Cable Management Hardware
 - 2. Patch Panels - Category 6 and category 6a

1.4 QUALITY ASSURANCE

- A. All equipment rooms shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract.
- B. Documents shall be subject to the control and approval of the Owners representative.
- C. Equipment and materials shall be of the quality and Manufacturer indicated.
- D. The equipment specified is based on the acceptable manufacturers listed.
- E. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to approval.
- F. Separation from sources of EMI shall be as specified in section.

- G. Communication grounding/earthing and bonding shall be in accordance with applicable codes and regulations. It is recommended that the requirements of ANSI/TIA-607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises throughout the entire cabling system.
- H. Materials and work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA-568.0-D Generic Telecommunications Cabling for Customer Premises.
 - 2. ANSI/TIA-568.1-D Commercial Building Telecommunications Cabling Standard.
 - 3. ANSI/TIA-568-D.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 - 4. ANSI/TIA-568.3-D Optical Fiber Cabling and Components Standard.
 - 5. ANSI/TIA-569-D-1, Telecommunications Pathways and Spaces.
 - 6. Underwriters Laboratory.
 - 7. Federal Communications Commission (including CFR 47 and Part 68 - subpart F).
 - 8. National Electric Code.
 - 9. Local and State Codes.
 - 10. ISO/IEC 11801.
 - 11. IEC 1000-5-2.
 - 12. CSA C22.2.
 - 13. IEC 60603-7.
- I. Manufacturers shall be ISO 9001 Certified, for all components that are required to have submittals provided as part of this section.

PART 2 – PRODUCTS

2.1 Cat.6a UTP CABLE

A.

Parameters	Performance @ 100 MHz
NEXT Loss	43.0 dB
FEXT	35.1 dB
Insertion Loss (Attenuation)	.4 dB
Return Loss	20 dB

- B. Be UL VERIFIED for TIA Category 6a electrical performance.
- C. Shall be UL Verified for Category 6a compliance and be CSA C22.2 approved.

2.2 CATEGORY 6A PATCH PANELS

- A. Be made of a steel frame with black power coat finish 24, 48, and 96 port configurations.
- B. Have mounting slots compatible with ANSI/EIA-310.
- C. Allows the modular insert to accept Panduit Minicom RJ 45 category 6A outlets as a means of

termination.

- D. Shall be T-568A or T-568B Wired.
- E. Provide 24 and 48 port panels, unless otherwise noted.
- F. Density must accommodate at least 24 port per single rack unit (1.75" or 44.5mm)
- G. Paired punch down sequence to allow pair twist within ½" of the termination.
- H. Shall have port identification numbers on front and rear of the panel.
- I. Support applications up to 500 MHz.
- J. Have circuit identification and color-coding designation strips provided with the panel.
- K. Provide port configurations and densities as called for on drawings.
- L. Provide rear cable management bar(s) as recommended by the Manufacturer.
- M. Shall be Insulation Displacement Connector 110 style terminations.
- N. Provide TIA 606-C compliant color-coded icons or color-coded designation label strips for all patch panels. Identify voice or data functionality as required.
- O. Paired punch down sequence to allow pair twist within ½" of the termination.
- P. Provide rear stress relief components as recommended by the manufacturer.
- Q. Acceptable Manufacturers:
Panduit/General. CPPLA48WBLY Mini-Com Angled Modular faceplate 48 port
1. Or Approved Equal.

2.3 PATCH PANELS - CATEGORY 6 - DATA

- A. The termination panels shall support the appropriate Category 6a applications and facilitate cross-connection and inter-connection using modular patch cords.
- B. Shall be sized to fit an TIA standard, 19-inch relay rack, or be capable of mounting to a wall.
- C. Be made of a steel frame with black power coat finish, in 48, -port configuration.
- D. Accommodate at least 24 ports for each rack mount space (1rms = 44.5 mm [1.75 in.]
- E. Have patented angle left/angle right modules to provide optimum cable management.

- G. Have removable six port modules to allow replacement in the field.
- H. Support applications up to 500 MHz
- I. Have Category 6 jacks available in universal T568A and T568B wiring schemes, with 110-style termination.
- K. Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
- L. Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.
- M. Have modular ports compliant with FCC CFR 47 part 68 subpart F and IEC 60603-7 with 50 micro inches of gold plating over nickel contacts or equivalent.
- O. Be fully enclosed front and provide rear plastic strips for physical protection of printed circuit board.
- P. Have port identification numbers on both the front and rear of the panel.
- Q. Provide clear label holders and white designation labels with the panel, with optional color labels available.
- R. Have circuit identification and color-coding designation strips provided with the panel.
- S. Be made by an ISO 9001 Certified Manufacturer.
- T. ANSI/TIA/EI-568-C and ISO/IEC 11801 proposed Category 6a channel compliant.
- U. The following requirements shall also be met (NEXT Loss and FEXT tested in both Differential and Common Mode):

Parameters	Performance @ 100 MHz
NEXT Loss	43.0 dB
FEXT	35.1 dB
Insertion Loss (Attenuation)	.4 dB
Return Loss	20 dB

- V. Be UL VERIFIED for TIA Category 6 electrical performance.
 - 1. Shall be UL Verified for Category 6a compliance and be CSA C22.2 approved.
 - 2. Provide TIA 606-C compliant color-coded icons or color-coded designation label strips for all patch panels. Identify voice or data functionality as required.
 - 3. Provide 48 port panels, unless otherwise noted
- W. Paired punch down sequence to allow pair twist within 1/2" of the termination.
- X. Shall have port identification numbers on front and rear of the panel.

- Y. Density must accommodate at least 24 port per single rack unit (1.75" or 44.5mm)
- Z. Have mounting slots compatible with ANSI/EIA-310.
- AA. Allows the modular insert to accept 110-style patch plugs as a means of Termination.
- BB. Shall be T-568B Wired.
- CC. Provide port configurations and densities as called for on drawings.
- DD. Provide rear cable management bar(s) as recommended by the manufacturer.
- EE. Shall be Insulation Displacement Connector 110 style terminations.
- FF. Provide rear stress relief components as recommended by the manufacturer.
- GG. Be UL verified for TIA Category 6a electrical performance.
- HH. Acceptable Manufacturers or Equal unless otherwise approved by Designer:

Panduit CPPLA48WBLY Mini-Com Angled Modular faceplate 48 port
1. Or approved equal

2.4 CATEGORY 6a PATCH CORDS - MATCH COLOR OF category 6a CABLES

- A. Shall be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.
- B. Be equipped with modular 8-position plugs on both ends, wired straight through with standards compliant wiring.
- C. Use modular plugs, which exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 microns minimum of gold plating over nickel contacts.
- D. Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.
- E. Utilize cable that exhibits power sum NEXT performance.
- F. Be available in several colors with or without color strain relief boots providing snagless design.
- G. Meet the flex test requirements of 1000 cycles with boots and 100 cycles without boots.
- H. Be available in any custom length and standard lengths of meters (3, 5, 7, 10, 15, 20, and 25 feet).
- I. Be made by an ISO 9001 Certified Manufacturer.
- J. Electrical Specifications:
 - 1. Input impedance without averaging $100 \pm 15\%$ from 1 to 500 MHz.

2. 100% transmission tested for performance up to 500MHz Manufacturer shall guarantee cords are compatible with Category 6a links.
3. Utilize cable that is UL VERIFIED (or equivalent) for TIA proposed Category 6a electrical performance.
4. UL LISTED 1863.

2.5 CATEGORY 6 PATCH CORDS - MATCH COLOR OF CATEGORY 6 CABLE

- A. Shall be round, and consist of eight insulated 23 or 24 AWG, solid or stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.
- B. Be equipped with modular 8-position plugs on both ends, wired straight through with standards compliant wiring.
- C. Be backwards compatible with lower performing categories.
- D. Use modular plugs, which exceed FCC CFR 47part 68 subpart F and IEC 60603-7 specifications, and have 50 microinches minimum of gold plating over nickel contacts.
- E. Have matching color strain relief boot with a snagless design which shall meet the flex testing as called out in 1000 cycles with boots and 100 cycles without boots.
- F. Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.
- G. Utilize cable that exhibits power sum NEXT performance.
- H. Be available in any custom length and standard lengths of (3, 5, 7, 10, 15, 20, and 25 feet).
- I. Be made by an ISO 9001 Certified Manufacturer.
- J. Electrical Specifications:
 1. Have input impedance without averaging: $100 \pm 15\%$ from 1 to 100 MHz, $\pm 22\%$ from 100 to 200 MHz and $\pm 32\%$ from 200 to 500 MHz
 2. Be 100% transmission tested for performance up to 500 MHz Manufacturer shall guarantee cords are compatible with proposed Cat-6a links.
 3. Utilize cable that is UL VERIFIED (or equivalent) for TIA Category 6a electrical performance.
 4. Be UL LISTED 1863

PART 3 - EXECUTION

3.1 CABLE MANAGEMENT

- A. Provide horizontal and vertical cable management in each cabinet; with horizontal cable management between each piece of electronics.
- B. A horizontal crossover cable manager shall be provided at the top and bottom of each relay rack, with

a minimum height of 2 rack units each.

- C. A horizontal crossover cable manager shall be provided near the center of each relay rack, with a minimum height of 4 rack units.
- D. Provide two rear cable management bars and reusable Velcro-type hook and loop straps in each rear vertical channel. Reusable straps shall be of varying sizes (each allowing 50% spare future expansion) and of adequate quantity to secure cable bundles at least every 4 rack units.
- E. Secure cable managers, slack managers, support bars, hook and loop straps per manufacturer recommendations.

3.2 CATEGORY 6a PATCH PANELS – DATA

- A. Install and label as recommended by manufacturer, per all TIA 606-C.
- B. Install rear cable management bar(s) as recommended by manufacturer.
- C. Install TIA 606-C compliant color-coded icons or color-coded designation label strips for all patch panels. Identify Data functionality.

3.3 CABLE SUPPORTS

- A. Provide “D” rings on 2 ft. center for all exposed wall mounted vertical Category 6a cable runs.
- B. Keep horizontal wall mounted cable runs to a minimum. In general horizontal runs shall be on wall mounted ladder rack.
- C. Provide cable brackets 3’ on center supported to building structure for all cable runs not supported by cable tray.

3.4 MISCELLANEOUS REQUIREMENTS

- A. All cables shall be neatly “dressed out” in equipment rooms.
- B. Provide service loops on all cables terminated in the telecommunications rooms, per the drawings.
- C. Firestop all sleeves and conduits openings after the cable installation is complete.

END OF SECTION 271100

SECTION 271500 – COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Horizontal (distribution) communications wiring and connecting hardware from the Telecommunications Room (IDF) to Telecommunication Outlets (TO) throughout the site.

1.2 REFERENCES

- A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
 1. NFPA 70 - National Electrical Code, current version adopted by local or State AHJ.
 2. ANSI/TIA-568.0-D Generic Telecommunications Cabling for Customer Premises
 3. ANSI/TIA-568.1-D Commercial Building Telecommunications Cabling Standard
 4. ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 5. ANSI/TIA-569-D-1, Telecommunications Pathways and Spaces.
 6. ANSI/TIA-526-14-C, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
 7. ANSI/TIA-606-C, Administration Standard for Commercial Telecommunications Infrastructure.
 8. ANSI/TIA-607-C, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 9. ANSI/TIA-1152-2009, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 10. ANSI/TIA TSB-162-A Telecommunications Cabling Guidelines for Wireless Access Points
 11. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings” pertaining to communication systems

1.3 SYSTEM DESCRIPTION

- A. The horizontal distribution subsystem refers to all intra-building twisted-pair and fiber optic communications cabling connecting Main Distribution Frames (MDF) and/or Intermediate Distribution Frames (IDF's) to telecommunication outlets (TO's) located at individual work areas.
- B. Horizontal cabling may consist of a combination of the following types of cable from the MDF/IDF to the TO:
 1. Category 6a, (500 MHz, 4-pair, ANEXT, unshielded twisted pair) cables from the MDF/IDF's to the TO's

- C. The Horizontal System includes cables, jacks, connectors, patch panels, connecting blocks, patch cords, fiber connectors and jumpers as well as the necessary support systems, such as cable managers and faceplates.
- D. Cables may be routed through conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above ceiling tile, and through plenum air-handling spaces above ceiling tile.
- E. Cable Contractor shall furnish and install all materials necessary for a complete and working system.
- F. All cables shall be plenum rated.

1.4 WARRANTY

- A. The Cable Contractor must be an approved manufacturer's Certified Contractor. The Cable Contractor is responsible for workmanship and industry standard installation practices. The certified contractor shall have 30% of their technicians trained on copper & fiber installations and testing by the manufacture; they also shall have at least 1 project manager.
- B. Cable Contractor shall provide labor, materials and documentation according to manufactures requirements necessary to ensure that the Owner will be furnished with a Warranty of 25 years in length.
- C. The copper warranty guarantees installed static channel (Includes patch cords) performance above the TIA Standards for CAT 6a cabling systems. The static channel performance tests shall be performed in the field with an approved Cable certification tester in the channel test configuration.
- D. Horizontal channel solution is to conform to all requirements of Category 6 and 6a performance.
- E. All necessary documentation for warranty registration must be provided to manufacturers will be furnished by the Cable Contractor immediately following 100% testing of all cables. All test results shall be submitted to manufactures in the certification tester's original software on CD.
- F. Cable Contractor shall administer the warranty process with the responsible manufacturer's representative. The warranty shall be provided directly to the owner from the manufacturer. Cable Contractor shall insure that the manufacturer provides the Owner with the appropriate warranty certification within 30 calendar days of the final project completion.

PART 2 - PRODUCTS

2.1 APPROVALS AND SUBSTITUTIONS

- A. All products shall be provided as specified without exception, unless approved in writing prior to the bid.
- B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Cable Contractor(s).

- C. All products shall be "NEW".

2.2 STATION CABLING

- A. Category 6A unshielded twisted pair, Plenum rated
- B. 100 ohm, Category 6a, 23 AWG, 4-pair unshielded twisted pair, 10Gain XP, CMP rated or Belden 10GXS13 CMP.
 - 1. Yellow (WAPs) Part# 6H-272-6B or Belden 10GXS13 0041000
 - 2. Orange (Clocks) Part# 6H-272-DB or Belden 10GXS13 0031000
 - 3. Data (Blue) Part# 6H-272-2B or Belden 10GXS13 D151000
 - 4. Security (Green) Part# 6H-272-5B or Belden 10GXS13 0051000
 - 5. Electrical Characteristics: Characterized to 500 MHz.
 - 6. Cable: Third-party verified by UL.
 - 7. Maximum Cable Diameter: 0.265 inch.
 - 8. Superior Essex 10Gain XP CMP or Belden 10GXS13 CMP
 - 9. All category cabling manufacturers must be able to provide documentation from an independent third-party testing agency that verifies through random sampling that cable components perform at or above the levels contained on their product specifications, not simply at or above the standard.

- C. Channel margin guarantees for a Cat 6a UTP System (margin vs. ANSI/TIA-568-C.2 and margin guarantees are for a 4-connector channel).

1.	Insertion Loss	3 %
2.	NEXT	4 dB
3.	PSNEXT	5 dB
4.	ACR-F (ELFEXT)	8 dB
5.	PSACR-F (PSELFEXT)	8 dB
6.	Return Loss	4 dB
7.	ACR-N	6 dB
8.	PSACR-N	7 dB
9.	PSANEXT	1 dB
10.	PSAACR-F	1 dB

- D. 500 MHZ, Category 6a, 4-pair unshielded twisted pair, CMP rated
 - 1. Manufacture
 - a. Superior Essex; Belden Or Approved Equal

2.3 MODULAR JACKS

- A. Category 6a modular jacks modular jacks

1. 8-position modular jack, Category 6a, IDC terminals, T568B wiring scheme
2. Each jack must be stamped or have icons to identify it as CAT 6a.
3. Color to be coordinated with building finishes and Architect.
4. Manufacturers:
 - a. Ortronics; Belden 10GX Modular jacks or REVConnect 10GX jacks Or approved equal

2.4 WORK AREA OUTLETS

A. Flush mounted faceplates

1. Single gang face plates constructed from fire retardant plastic with label fields, mounts within a double gang wall box with reducer plate.
 - a. Legrand/Ortronics
 - 1) Single gang 1 port for Ortronics TraJackOR-40300549 for Belden AX102660
 - 2) Single gang 2 port for Ortronics TraJackOR-40300548 for Belden AX102655
 - 3) Single gang 4 port for Ortronics TraJackOR-40300546 for Belden AX102249
 - 4) Wall Phone Plate – TraJack STJ12Stainless Steel for Belden AX104231
 - 5) Wall plate with: HDMI, RCA Component (Red, Green, Blue), RCA Composite (Red, White, Yellow) Series II OR-40300158 or Belden Faceplate AX102249 with HDMI Coupler AX105345-EW, RCA Red AX105337-EW, Green AX105340-EW, Blue AX105341-EW,
 - 6) Wall outlet with: HDMI, BNC, CAT 6a jack Keystone style
 - a) Wall Plate OR-KSFP3-3 position or Belden Faceplate AX102249 – 4 position
 - b) HDMI – OR-KSHDMI or Belden HDMI Coupler AX105345-EW
 - c) USB - OR-KSUSBAA or Belden USB 3.0 A to A - AX105342-EW; USB 2.0 B to B – AX105344-EW
 - d) Belden BNC – AX104575
 - e) CAT 6a jack – OR-KT2J6A-xx-(xx denotes color) or Belden KeyConnect 10GX Yellow AX104154, Orange AX104152, Blue AX104156, Green AX104155; REVConnect 10GX Bulk 24 units Yellow RVAMJKUYL-B24, Orange RVAMJKUOR-B24, Blue RVAMJKUBL-B24, Green RVAMJKUGN-B24
 - f) Belden REVConnect Category 6a Plugs PART # - RVAFPUBK-B24 (Bulk) optional termination for use with WAP's and Security Cameras only.
 - f. Or Approved Equal
2. All unused plate opening are to be provided with a blanking insert - color shall match that of the plate.
3. All faceplate colors are to be coordinated with owner to match finish.

Commented [r1]: USB or BNC?

2.5 PATCH PANELS

A. Category 6A Patch Panels

1. Cat 6a 110-Style Patch Panel, 24-Port, 1RU.
 - a. Ortronics- PART #OR-PHD6AU24
 - b. Belden KeyConnect – PART # AX103254 or REVConnect PART # RVAPPF1U24BK
 - c. Or Approved Equal.
2. Cat 6a 110-Style Patch Panel, 48-Port, 2RU

- a. Ortronics- PART # PHD6AU48
 - b. Belden KeyConnect – PART # AX103256 or REVConnect PART # RVAPPF2U48BK
3. Or Approved Equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Horizontal cabling includes cables, jacks, patch panels, connecting blocks, and patch cords, as well as the necessary support systems, such as cable managers and faceplates.
- B. Cable Contractor shall furnish and install all materials necessary for a complete and working system.
- C. Cable Contractor must be a Certified Systems Vendor for the cable system bid and installed - up to, during, and through completion of the system installation, and must be able to provide the manufacturer's extended warranty.
- D. Field terminated copper and fiber optic patch cords and jumpers are not allowed.
- E. All work shall be performed in a professional manner.
- F. Install cable after interior of building has been physically protected from the weather and all mechanical work likely to damage cabling has been completed.
- G. Before installing cabling, ensure all cable pathways are completely and thoroughly cleaned:
- H. Inspect conduit, wire-way, cable trays and innerduct installed by others.
- I. Clean any additional enclosed raceway and innerduct systems furnished.
- J. Provide protection for exposed cables where subject to damage.
- K. Provide abrasion protection for any cable or wire bundles, which pass through holes or across edges of sheet metal. Protective bushings shall be used to protect cables.
- L. Velcro type Cable ties and other cable management clamps shall be no more than hand tightened and shall fit snugly, but not compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices. Plenum spaces require Plenum rated cable ties.
- M. Where possible, route cables in overhead cable trays and inside wire management systems attached to the equipment cabinets and racks. Use plastic ties or ducts to restrain cabling installed outside of wire management systems on racks or in cabinets. Cable trays shall not exceed 50% fill.
- N. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

- O. Cable raceways shall not be filled greater than the ANSI/TIA-569-D-1, Telecommunications Pathways and Spaces-A maximum fill for the particular raceway type.
- P. A cable basket system shall be used to support cable bundles through-out the building. All cable basket shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable basket rest on acoustic ceiling grids, plumbing pipes, and electrical conduits.
- Q. Horizontal distribution cables shall be bundled in groups of no more than the amount of cables designed for by the cable basket manufacturer recommends based on cable OD and weight. The cable basket system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- R. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Cable Contractor shall install appropriate carriers to support the cabling.
- S. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Cable Contractor prior to final acceptance at no cost to the Owner.
- T. Telecom integrator to coordinate final location of all devices with client.

3.2 UNSHIELDED TWISTED PAIR CABLE INSTALLATION PRACTICES

- A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
- B. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- C. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- D. The cable's minimum bend radius and maximum pulling tension shall not be exceeded Bend radius for as outlined in ANSI/TIA.
- E. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- F. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.
- G. Separation from Power Lines: Provide the following minimum separation distances between pathways for copper communications cables and power wiring of 480 volts or less:
 - I. Open or Nonmetal Communications Pathways:
 - a. 12 inches from electric motors, fluorescent light fixtures, and unshielded power lines carrying up to 3 kVA.
 - b. 36 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
 - c. 48 inches from large electrical motors or transformers.

2. Grounded Metal Conduit Communications Pathways:
 - a. 2 1/2 inches from electrical equipment and unshielded power lines carrying up to 2 kVA.
 - b. 6 inches from electrical equipment and unshielded power lines carrying from 2 kVA to 5 kVA.
 - c. 12 inches from electrical equipment and unshielded power lines carrying more than 5 kVA.
 - d. 3 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying from 2 kVA to 5 kVA.
 - e. 6 inches from power lines enclosed in a grounded metal conduit (or equivalent shielding) carrying more than 5 kVA.

3.3 UNSHIELDED TWISTED PAIR TERMINATION

- A. Cables shall be coiled to house the cable coil without exceeding the manufacturers bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored; Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.
- B. Cables shall be dressed and terminated in accordance with the recommendations made in the latest version of ANSI/TIA -568-C document, manufacturer's recommendations and best industry practices.
- C. All 4 pair cables shall be terminated on the jack and patch panels using T568-B wiring scheme - CONFIRM FINAL TERMINATION CONFIGURATION WITH DESIGN ENGINEER OR CLIENT PRIOR TO BEGINNING TERMINATIONS
- D. Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- E. Bend radius of the horizontal cable shall not be less than 4 times the outside diameter of the UTP cable. 8 times for FTP cables.
- F. The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- G. Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- H. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- I. The cable jacket shall be maintained as close as possible to the termination point. Cable shall not have more than 1.0" removed.

3.4 TESTING PROCEDURES

- A. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the latest requirements of

ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

- B. All cables shall be tested in accordance with this document, the ANSI/TIA standards, and best industry practice. If any of these are in conflict, the Cable Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.
- C. Cables, jacks, connecting blocks, and patch panels shall be in their final position with the building energized.
- D. All Unshielded Twisted Pair cables shall be tested as follows:
 - 1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using an approved certification tester (Fluke or Equal) for Category 6A performance compliance as specified in ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
 - 2. Follow the Standards requirements established in ANSI/TIA-568-C.2.
 - 3. Testing shall be accomplished with an approved certification tester (Fluke is preferred)
 - 4. The basic tests required are:
 - a. Wire Map
 - b. Length (feet)
 - c. Insertion Loss (dB) (Formerly Attenuation)
 - d. NEXT (Near end crosstalk) (dB)
 - e. Return Loss (dB)
 - f. ELFEXT (dB)
 - g. Propagation Delay (ns)
 - h. Delay skew (ns)
 - i. PSNEXT (Power sum near-end crosstalk loss) (dB)
 - j. PSELFEXT (Power sum equal level far-end crosstalk loss) (dB)
 - k. Note: CAT 6a cable shall be tested to a CAT 6a auto test to 500 MHz.
 - 5. All test results shall be provided in the approved certification testers original software format on a CD, with the following minimum information per cable:
 - a. Circuit ID
 - b. All information from 3.4D.4 above.
 - c. Test result, "Pass" or "Fail"
 - d. Date and Time of test
 - e. Project Name
 - f. NVP
 - g. Version of software
 - h. Note: No asterisk * will be accepted by client. These results shall be retested and submitted after a PASS is received.
 - 6. A software copy of the test results, in the original tester software format, shall be provided to the Owner and Belden.
 - 7. Cable Contractor shall provide a fully functional version of the tester software for use by the Owner in reviewing the test results.

8. Any failed test results that cannot be remedied through re-termination (as in the case of reversed or split pairs), must be reported in writing to the Owner immediately, along with a copy of the test results.

3.5 LABELING

- A. All horizontal cables are to be labeled using a machine printed label at each end of the cable at approximately 12 inches of the termination point, and again at approximately 48 inches from the termination point. Handwritten labels shall not be used.
- B. All patch panel ports and TO ports shall be labeled with the cable identifier.
- C. The labels shall denote the TO ID, as well as the unique cable number for that TO, i.e. A-001-A for cable number 1, A-001-B for cable number 2, and so forth. Owner may provide specific labeling requirements coordinate with owner.
- D. Note all labeling information on the as-built drawings.

END OF SECTION 271500

SECTION 28 46 21.11 - ADDRESSABLE FIRE-ALARM SYSTEMS**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Addressable fire-alarm system.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Duct smoke detectors.
5. Carbon monoxide detectors.
6. Heat detectors.
7. Multicriteria and multisensor fire detectors.
8. Fire-alarm notification appliances.
9. Fire-alarm addressable interface devices.

B. Related Requirements:

1. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables".

1.3 DEFINITIONS

- A. DACT: Digital alarm communicator transmitter.
- B. EMT: Electrical metallic tubing.
- C. FACU: Fire-alarm control unit.
- D. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).
- E. NICET: National Institute for Certification in Engineering Technologies.
- F. PC: Personal computer.
- G. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
 2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.4 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, including furnished options and accessories.
 - 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. Detail assembly and support requirements.
 - 5. Include voltage drop calculations for notification-appliance circuits.
 - 6. Include battery-size calculations.
 - 7. Include input/output matrix.
 - 8. Include 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.
 - 9. Include performance parameters and installation details for each detector.
 - 10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.
 - 12. 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.
 - 13. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates:
 - 1. Seismic Performance Certificates: For FACU, accessories, and components, from manufacturer. Include the following information:
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

- c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - B. Field quality-control reports.
 - C. Qualification Statements: For Installer.
 - D. Sample Warranty: Submittal must include line-item pricing for replacement parts and labor.
- 1.6 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 01 78 23 "Operation and Maintenance Data," include the following:
 - 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. Record copy of site-specific software.
 - g. 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.
 - h. Manufacturer's required maintenance related to system warranty requirements.
 - i. 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.
- 1.7 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: 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 tamperproofed components.
4. Audible and Visual Notification Appliances: Two of each type installed.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
2. Installation must be by personnel certified by NICET as fire-alarm Level II technician.
3. Obtain certification by NRTL in accordance with NFPA 72.
4. Licensed or certified by authorities having jurisdiction.

1.9 FIELD CONDITIONS

A. Seismic Conditions: Unless otherwise indicated on Contract Documents, specified Work in this Section must withstand the seismic hazard design loads determined in accordance with ASCE/SEI 7 for installed elevation above or below grade.

1. The term "withstand" means "unit must remain in place without separation of parts from unit when subjected to specified seismic design loads.

1.10 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ADDRESSABLE FIRE-ALARM SYSTEM

A. Description:

1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn-and-strobe notification for evacuation. System shall be listed and labeled for use with existing fire alarm control unit.

B. Performance Criteria:

1. Regulatory Requirements:

- a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.

2. General Characteristics:

- a. Automatic sensitivity control of certain smoke detectors.
- b. Fire-alarm signal initiation must be by one or more of the following devices:
 - 1) Manual stations.
 - 2) Heat detectors.
 - 3) Smoke detectors.
 - 4) Duct smoke detectors.
 - 5) Carbon monoxide detectors.
 - 6) Automatic sprinkler system water flow.
- c. Fire-alarm signal must initiate the following actions:
 - 1) Continuously operate alarm notification appliances.
 - 2) Identify alarm and specific initiating device at FACU and remote annunciators.
 - 3) Transmit alarm signal to remote alarm receiving station.
 - 4) Unlock electric door locks in designated egress paths.
 - 5) Release fire and smoke doors held open by magnetic door holders.
 - 6) Switch HVAC equipment controls to fire-alarm mode.
 - 7) Recall elevators to primary or alternate recall floors.
 - 8) Activate emergency lighting control.
 - 9) Activate emergency shutoffs for gas and fuel supplies.
 - 10) Record events in system memory.
 - 11) Record events by system printer.
- d. Supervisory signal initiation must be by one or more of the following devices and actions:
 - 1) Valve supervisory switch.
 - 2) Zones or individual devices have been disabled.
 - 3) FACU has lost communication with network.
- e. System trouble signal initiation must be by one or more of the following devices and actions:
 - 1) Open circuits, shorts, and grounds in designated circuits.
 - 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - 4) Loss of primary power at FACU.
 - 5) Ground or single break in internal circuits of FACU.
 - 6) Abnormal ac voltage at FACU.
 - 7) Break in standby battery circuitry.
 - 8) Failure of battery charging.
 - 9) Abnormal position of switch at FACU or annunciator.
- f. System Supervisory Signal Actions:
 - 1) Initiate notification appliances.
 - 2) Identify specific device initiating event at FACU and remote annunciators.
 - 3) Record event on system printer.

- 4) After time delay of 200 seconds, transmit trouble or supervisory signal to remote alarm receiving station.
- 5) Transmit system status to building management system.

g. Network Communications:

- 1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
- 2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.
- 3) Provide integration gateway using BACnet for connection to building automation system.

h. Document Storage Box:

- 1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
- 2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
- 3) Color: Red powder-coat epoxy finish.
- 4) Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
- 5) Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.

2.2 FIRE-ALARM CONTROL UNIT (FACU)

- A. The existing Fire alarm control unit shall remain and be re-used for connection of new devices to support the updated building requirements.

B. Performance Criteria:

1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
2. General Characteristics:
 - a. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - 1) Pathway Class Designations: NFPA 72, Class A.
 - 2) Pathway Survivability: Level 1.
 - 3) Install no more than 256 addressable devices on each signaling-line circuit.
 - 4) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.
 - b. Smoke-Alarm Verification:
 - 1) Initiate audible and visible indication of "alarm-verification" signal at FACU.
 - 2) Activate approved "alarm-verification" sequence at FACU and detector.
 - 3) Record events by system printer.
 - 4) Sound general alarm if alarm is verified.
 - 5) Cancel FACU indication and system reset if alarm is not verified.

- c. Notification-Appliance Circuit:
 - 1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
 - 2) Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
 - 3) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.

C. Accessories:

- 1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE-ALARM BOXES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:

- 1. **Honeywell.**

- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

- 1. Double-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
- 2. Station Reset: Key- or wrench-operated switch.
- 3. Able to perform at up to 90 percent relative humidity at 90 deg F.
- 4. Material: Manual stations made of Lexan polycarbonate.
- 5. Able to be used in indoor areas.

2.4 SYSTEM SMOKE DETECTORS

- A. Photoelectric Smoke Detectors:

- 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:

- a. **Honeywell.**

- 2. Performance Criteria:

- a. Regulatory Requirements:

- 1) NFPA 72.
- 2) UL 268.

b. General Characteristics:

- 1) Detectors must be four-wire type.
- 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
- 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- 5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
- 7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - a) Primary status.
 - b) Device type.
 - c) Present average value.
 - d) Present sensitivity selected.
 - e) Sensor range (normal, dirty, etc.).
- 8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
- 9) Color: White.
- 10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
- 11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F per minute.
- 12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F.
- 13) Multiple levels of detection sensitivity for each sensor.
- 14) Sensitivity levels based on time of day.

B. Ionization Smoke Detectors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:
 - a. Honeywell.
2. Performance Criteria:
 - a. Regulatory Requirements:

- 1) NFPA 72.

2) UL 268.

b. General Characteristics:

- 1) Detectors must be four-wire type.
- 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
- 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- 5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
- 7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - a) Primary status.
 - b) Device type.
 - c) Present average value.
 - d) Present sensitivity selected.
 - e) Sensor range (normal, dirty, etc.).
- 8) Detector must have functional humidity range within 10 to 90] percent relative humidity.
- 9) Color: White.
- 10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
- 11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F per minute.
- 12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F.
- 13) Multiple levels of detection sensitivity for each sensor.
- 14) Sensitivity levels based on time of day.

2.5 DUCT SMOKE DETECTORS

A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:

1. **Honeywell.**

B. Description: Photoelectric-type, duct-mounted smoke detector.

C. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. UL 268A.

2. General Characteristics:

- a. Detectors must be four-wire type.
- b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- e. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
- f. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
- g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
- h. Each sensor must have multiple levels of detection sensitivity.
- i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 CARBON MONOXIDE DETECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:

1. Honeywell.

- B. Description: Carbon monoxide detector listed for connection to fire-alarm system.

- C. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72
- b. NFPA 720.
- c. UL 2075.

2. General Characteristics:

- a. Mounting: Adapter plate for outlet box mounting.
- b. Testable by introducing test carbon monoxide into sensing cell.

- c. Detector must provide alarm contacts and trouble contacts.
- d. Detector must send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
- e. Locate, mount, and wire in accordance with manufacturer's written instructions.
- f. Provide means for addressable connection to fire-alarm system.
- g. Test button simulates alarm condition.

2.7 HEAT DETECTORS

A. Combination-Type Heat Detectors:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:
 - a. **Honeywell.**
2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.
 - b. General Characteristics:
 - 1) Temperature sensors must test for and communicate sensitivity range of device.
 - c. Actuated by fixed temperature of 135 deg F or rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - d. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - f. Detector must have functional humidity range of 10 to 90 percent relative humidity.
 - g. Color: White.

B. Fixed-Temperature-Type Heat Detectors:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:
 - a. **Honeywell.**
2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.
 - b. General Characteristics:

- 1) Actuated by temperature that exceeds fixed temperature of 190 deg F.
- 2) Mounting: Twist-lock base interchangeable with smoke-detector bases.
- 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- 4) Detector must have functional humidity range of 10 to 90 percent.
- 5) Color: White.

2.8 MULTICRITERIA AND MULTISENSOR FIRE DETECTORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:

1. **Honeywell.**

- B. Description: Fire-sensing detectors using multiple means of detection.

- C. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.

2. General Characteristics:

- a. Mounting: Twist-lock base interchangeable with smoke-detector bases.
- b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- c. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. Detector must send trouble alarm if it is incapable of compensating for existing conditions.
- d. Test button tests sensors in detector.
- e. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present sensitivity selected.
 - 4) Sensor range (normal, dirty, etc.).
- f. Detector must have functional humidity range within 10 to 90 percent relative humidity.
- g. Color: White.
- h. Comply with UL and FM Global requirements.
- i. Sensors (Multisensor Type): Detector must be comprised of four sensing elements including smoke sensor, carbon monoxide sensor, infrared sensor, and heat sensor.
 - 1) Smoke sensor must be photoelectric type as described in "System Smoke Detectors" Article.
 - 2) Carbon monoxide sensor must be as described in "Carbon Monoxide Detectors" Article.
 - 3) Heat sensor must be as described in "Heat Detectors" Article.

- 4) Each sensor must be separately listed in accordance with requirements for its detector type.

2.9 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Audible Notification Appliances:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:
 - a. **Honeywell.**
2. Description: Horns, bells, or other notification devices that cannot output voice messages.
3. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - b. General Characteristics:
 - 1) Audible notification appliances must have functional humidity range of 10 to 95 percent relative humidity.
 - 2) ISO Temporal 3 Evacuation Tone: 90 plus or minus 4 dB(A-weighted)] at 24 V.
 - 3) Horns: Electric-vibrating-polarized type, 24 V(dc); with provision for housing operating mechanism behind grille. Comply with UL 464. Horns must produce sound-pressure level of 90 dB(A-weighted), measured 10 ft. from horn, using coded signal prescribed in UL 464 test protocol.
 - 4) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Fire-Alarm Visible Notification Appliances:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:
 - a. **Honeywell.**
2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 1971.
 - b. General Characteristics:
 - 1) Rated Light Output:
 - a) 177 cd.

- b) 15/30/75/110 cd, selectable in field.
- 2) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
- 3) Mounting: Wall mounted unless otherwise indicated.
- 4) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
- 5) Flashing must be in temporal pattern, synchronized with other units.
- 6) Strobe Leads: Factory connected to screw terminals.
- 7) Mounting Faceplate: Factory finished, **[red]** **[white]**.

2.10 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work must be UL labeled and listed for use with the existing Honeywell fire alarm control unit include, but are not limited to the following:

- 1. [Honeywell](#).

- B. Performance Criteria:

- 1. Regulatory Requirements:

- a. NFPA 72.

- 2. General Characteristics:

- a. Include address-setting means on module.
- b. Store internal identifying code for control panel use to identify module type.
- c. Listed for controlling HVAC fan motor controllers.
- d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
- e. Integral Relay: Capable of providing direct signal to elevator controller to initiate elevator recall.
 - 1) Allow control panel to switch relay contacts on command.
 - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
- f. Control Module:
 - 1) Operate notification devices.
 - 2) Operate solenoids for use in sprinkler service.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
 - B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
 - C. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 PREPARATION
- A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
 - B. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.
- 3.3 INSTALLATION OF EQUIPMENT
- A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 1. Devices placed in service before other trades have completed cleanup must be replaced.
 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
 - B. Install wall-mounted equipment, with tops of cabinets not more than 78 inch above finished floor.
 1. Comply with requirements for seismic-restraint devices specified in Section 27 05 48.16 "Seismic Controls for Communications Systems."
 - C. Manual Fire-Alarm Boxes:
 1. Install manual fire-alarm box in normal path of egress within 60 inch of exit doorway.
 2. Mount manual fire-alarm box on background of contrasting color.
 3. Operable part of manual fire-alarm box must be between 42 and 48 inch above floor level. Devices must be mounted at same height unless otherwise indicated.
 - D. Smoke- and Heat-Detector Spacing:
 1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing must not exceed 30 ft.].
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A or Annex B in NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inch from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inch from lighting fixture and not directly above pendant mounted or indirect lighting.

- E. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch long must be supported at both ends.
 - 1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- G. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inch below ceiling. Install horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch below ceiling. Install devices at same height unless otherwise indicated.
- J. Device Location-Indicating Lights: Locate in public space near device they monitor.
- K. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists wind load of 100 mph with gust factor of 1.3 without damage.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
 - 2. Nameplate must be laminated acrylic or melamine plastic signs with black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

- A. Pathways must be installed in EMT.
- B. Exposed EMT must be painted red enamel.

3.7 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 08 71 00 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Magnetically held-open doors.
 - 3. Electronically locked doors and access gates.
 - 4. Alarm-initiating connection to elevator recall system and components.
 - 5. Alarm-initiating connection to activate emergency lighting control.
 - 6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 7. Supervisory connections at valve supervisory switches.
 - 8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 9. Data communication circuits for connection to building management system.

3.8 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install framed instructions in location visible from FACU.

3.9 GROUNDING

- A. Ground FACU and associated circuits in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

- A. Administrant for Tests and Inspections:
 - 1. Owner will engage qualified testing agency to administer and perform tests and inspections.
 - 2. Engage qualified testing agency to administer and perform tests and inspections.
 - 3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
 - 4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

3.12 MAINTENANCE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.13 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 28 46 21.11