

PROPOSAL FORM
BALTIMORE COUNTY
DEPARTMENT OF PUBLIC WORKS & TRANSPORTATION
TOWSON, MARYLAND

Division of Construction Contracts Administration

ARCHITECT

Henry Adams Consulting Engineers
600 Baltimore Avenue; Suite 400
Towson, Maryland 21204
Phone: 410-296-6500
Email: puszcz@henryadams.com
Peter Puszcz



Contract Number 24146 PO0
Property Management Project
North point Library HVAC Renovation –
1716 Merritt Boulevard, Dundalk, Maryland 21222
Dundalk – District 12c7
Workday Number
PROJ-10000216

CONTRACT BASED ON SEPTEMBER 2023
STANDARD SPECIFICATIONS FOR CONSTRUCTION AND MATERIALS
AND STANDARD DETAILS FOR CONSTRUCTION

Bidders Information

A pre-bid meeting will be held on Wednesday, June 4, 2025 at 11:00 a.m. EST via WebEx. *Phone-In* (Audio Only) 1-415-655-0001, Meeting Number 2314 061 1470##. *Video Conference* go to <https://signin.webex.com/join> Meeting Number 2314 061 1470, **Password: rqM3i3yJcF3**, for Webex link go to: www.baltimorecountymd.gov/departments/public-works/engineering/contracts/current-solicitations

Baltimore County Prevailing Wage and Local Hiring Affidavit, Wage Rates & Requirements **see pages 801-808**

(Contract Disclosure): “Wage rates that are in effect as of the contract solicitation date will be the wage rates through the duration of the project”

MBE/WBE Requirements & Forms **see pages 809-823**

THIS PROPOSAL FORM INCLUDES AND INCORPORATES ALL DOCUMENTS AND INFORMATION REFLECTED, LISTED, AND/OR REFERENCED IN THIS TABLE OF CONTENTS, AND ALL SUCH DOCUMENTS AND INFORMATION ARE PART OF AND INCORPORATED INTO THE CONTRACT DOCUMENTS.

TABLE OF CONTENTS

<u>Section Number</u>	<u>SECTION NAME</u>	<u>Page Number</u>
	Title Page (cover)	1
	Table of Contents	2
I.	INFORMATION FOR BIDDERS	3-6
II.	SPECIAL PROVISIONS	7-789
	(General Provisions)	(11-12)
	(General Conditions)	(13-42)
III.	PERMITS.....	790
IV.	PROPOSAL (This section to be completed at time of bid)	791
	Description of Work	792
	Description of Items & Schedule of Prices	793
	Proposal Affidavit	794-799
	Bid Bond	800
	Baltimore County Prevailing Wage and Local Hiring Affidavit, Wage Rates and Requirements.....	801-808
	MBE/WBE Requirements and Forms	809-823
V.	POST AWARD DOCUMENTS (This Section to be completed by successful bidder after award)	824
	Contract Agreement	825-827
	Performance Bond	828
	Payment Bond	829
	Insurance Documents	830

SECTION I

INFORMATION FOR BIDDERS

ELECTRONIC SUBMITTAL PROCESS

To be considered, Bids (Section IV – Proposal) shall be received by the bid closing date and time to the following email address dpwbid@baltimorecountymd.gov. The contract number and company name should be referenced in the Subject Line of the email. Bids may not be submitted by any other means. Bids that are mailed or otherwise delivered to the Purchasing Division (including emails which indicate links to locations where the bid may be downloaded) and/or emails sent to any other Baltimore County email address will not be accepted.

Late Bids will not be considered. Bidders are strongly encouraged not to wait until the last minute to submit bids. The time stated on the auto-receipt (described below) will be definitive of the time of receipt. Bids received after the deadline will not be accepted. Bidders are advised that the County cannot receive email attachments greater in size than twenty-five (25) megabytes and this size limitation may be further reduced by requirements of the Bidder's email provider which are beyond the control of the County. Bidder should consider separating any large bid attachment into multiple parts and emailing each part separately. In such case, Bidder will note that each email is *1 of 2, 2 of 2*, etc. Multiple part bids will not be considered unless all parts are received by the bid closing date and time.

After submitting a Bid to dpwbid@baltimorecountymd.gov, and upon successful receipt by the County thereof, Bidder will receive an auto-receipt email. This receipt is proof that the bid has been received by the Division of Construction Contracts Administration and should be retained for Bidder's records. In the case of a bid submitted in multiple parts as described above, an auto-receipt email will be generated for each part. The County has no obligation to consider any Bid for which an auto-receipt was not generated.

As with any system, power outages or technology problems may arise that are outside of the County's control and could affect your submission. The County will not be held accountable for such issues that may delay the transmission of any Bid.

NOTE: Electronic copy of the Bid Bond will be accepted at bid opening. The apparent low bidder is required to submit the original Bid Bond within ten (10) days after the bid opening to the Division of Construction Contracts Administration, 111 West Chesapeake Avenue, Room 300B, Towson, Maryland 21204.

INSTRUCTIONS AND SPECIFICATIONS

Refer to the enclosed proposal sheets for quantities to be bid upon. All proposals submitted on the attached form must give the price in clear figures for each item of the proposed work and be signed by the bidder with his name and address. Bidders must not change any item in the proposal for which a price has been stipulated by the County. Any change will cause rejection of the proposal.

NOTE: STATEMENT UNDER OATH FORM TO ACCOMPANY BID as per Baltimore County Purchasing Act 65-98, Section 15-94 and 15-95 which requires that the enclosed affidavit (see Proposal Affidavit pages in Section IV) be completed and submitted as part of the sealed bid.

Proposals made on any other than the attached form will not be considered. All papers included in, bound thereto, or attached to the Proposal Form are necessary parts thereof and shall not be detached, separated, or altered in their intent.

Changes in the phraseology of the proposal, additions, or limiting provisions will render the proposal informal or void and may cause its rejection.

All right is hereby reserved by the Purchasing Agent to reject any or all proposals and to waive formalities and technicalities as the interest of the County may require.

No successful bidder may withdraw his bid within NINETY (90) days after the opening thereof.

The successful bidder will be required to be bonded to Baltimore County, Maryland to the sum of One Hundred per Cent (100%) of the amount of his proposal or proposals according to the form of bond hereto attached for projects in excess of \$25,000.00.

This Proposal must be accompanied by a Bid Bond in an amount of 5% of the bid, the exact amount to be determined by the difference between the low bid and the next lowest bid if two or more bids are received, or 5% of the bid if one bid is received. This guarantees payment of the amount thus determined in case of a default in any matter specified as required before award or in any matter resulting in failure to execute and deliver an Agreement, together with Payment and Performance Bonds, after award. The Bid Bond must be in the form accompanying the Proposal executed by a Surety licensed in the State of Maryland. The Surety must be currently rated "B" or better by the A. M. Best Company, and the bid must be in an amount less than, or equal to, the underwriting limitation contained in Department of Treasury Circular 570 as amended at the time of the underwriting.

All work to be performed under this contract shall be done under strict compliance with Baltimore County Department of Public Works and Transportation September 2023 Standard Specifications for Construction and Materials and Standard Details for Construction and any and all proposed revisions thereto as of the date of advertisement and copies of which are available on the County's website at www.baltimorecountymd.gov/departments/public-works/standards, and all of which are made a part hereof and incorporated herein (collectively, the "Specifications").

If the bidder to whom an award is made shall fail to execute the contract and bond hereto attached and as herein provided, the award may be annulled and the contract awarded to the lowest responsible bidder who has consented to a time extension, and such bidder shall fulfill every stipulation embraced herein as if he were the original party to whom the award was made, or the Purchasing Agent may reject all of the bids as the interest of the County may require.

The Bid Bond of the three lowest bidders is deemed to be effective until the execution and delivery of the Contract Agreement, together with Payment and Performance Bonds for projects in excess of \$25,000.00 or until rejection of all bids, whereupon Surety is deemed relieved of all further obligations under the bid bonds provided.

Bidders must examine the drawings and specifications carefully and must make a personal examination of the location and nature of the proposed work. In case doubt shall arise as to the meaning or intent of anything shown on the drawings or comprised in the specification, inquiry shall be made of the Director of Public Works and Transportation at least five (5) days prior to the date of

bid opening. The submission of the Proposal shall indicate that the bidder thoroughly understands the drawings and the terms of the Specifications.

To better ensure fair competition and to permit a determination of the lowest bidder, unresponsive bids or bids obviously unbalanced may be rejected by the Purchasing Agent.

Bidders are required to fill out the total price column and total their proposals so that the result of the bidding, barring possible arithmetical errors, will be known at once. Any errors in computations will be corrected by the Engineer when the proposals are canvassed. Where the unit price and the total price are at variance, the unit price will prevail.

Bidders must be prepared to complete the work within the time stated in the proposal.

NOTE: ONLY CONTRACTORS FORMALLY PRE-QUALIFIED WITHIN THE ADVERTISED WORK CLASSIFICATION BY THE DIRECTOR OF PUBLIC WORKS AND TRANSPORTATION OF BALTIMORE COUNTY 10 CALENDAR DAYS PRIOR TO BID OPENING WILL BE ELIGIBLE TO SUBMIT BIDS.

Contracts for work under this proposal will obligate the contractors and subcontractors not to discriminate in employment practices. Bidders must, if requested, submit a compliance report concerning their employment practices and policies in order to maintain their eligibility to receive the award of the contract. Successful bidders must be prepared to comply in all respects with the Contract Provisions regarding nondiscrimination.

Baltimore County has adopted a Minority Business Enterprise (MBE) program and Women's Business Enterprise (WBE) Program. The percentage of participation applies to the contract amount awarded to the Contractor. Qualified minority subcontractors are those certified as being a Minority Business Enterprise by the following:

1. Maryland Department of Transportation Certification Committee (MDOT)
2. City of Baltimore, Minority Business Certification Council

Projects funded by the Federal Highway Administration are limited to the certification listed under #1 (MDOT).

More detailed information regarding the County's MBE/WBE Program can be obtained from the County MBE Office, telephone (410) 887-3407. See Executive Order dated December 6, 2022. MBE/WBE Participation Summary and Forms A, B, C, D and E enclosed in this proposal booklet.

NOTE: If you do not complete and submit the enclosed forms with your bid or offer to the County, the County may, in its sole discretion, deem your bid or offer **NON-RESPONSIVE** and accordingly the **COUNTY WILL NOT CONSIDER YOU FOR CONTRACT AWARD.**

The County reserves the right to require the low bidder to produce evidence indicating that the company's financial condition is equal to, or better than, that enjoyed by the company at the time of prequalification. This additional information may be in the form of a financial statement or other evidence satisfactory to the Office of Budget and Finance.

Bidders' attention is directed to the requirement that a permit must be obtained from the Baltimore County Bureau of Highways and Bureau of Traffic Engineering prior to cutting any County

road for the purpose of obtaining sub-surface soils information, and permission must be obtained from the State Highways Administration prior to making any openings in a State road.

Under no circumstances shall a bidder enter upon any property outside a County or State road for the purpose of securing sub-surface soils information until permission is received from the property owner. The fact that the County has obtained a utility easement does not give the bidder the right to enter upon the property.

Prevailing index price of asphalt cement/ton \$640.00.

INCLEMENT WEATHER POLICY: If Baltimore County General Government Offices are open or open with liberal leave the day the bids are due, the bids are due as stated in the bid documents (date and time). **ONLY** when the Baltimore County General Government Offices are **OFFICIALLY CLOSED** the day the bids are due, the bid date will be postponed and an Addendum will be issued the next business (or next day buildings are officially open) day the county offices are open with the new bid date and time.

BID TABULATIONS: All bid tabulations will be confidential until after final award, at which time the total bid amounts for all bidders, as well as the complete bid tabulations for the top three (3) bidders, can be inspected by others when requested in writing pursuant to the Maryland Public Information Act.

ALTERNATIVE SOURCES OF CONTRACT BONDS: In the event your company is unable to qualify for bonding through a traditional commercial surety company, you may qualify for the required bonds through the State of Maryland, Department of Commerce (DOC). The **Maryland Small Business Development Financing Authority (MSBDFA, pronounced Mis-Bid-Fa)**, an agency of DOC, operates a Surety Bond Program designed to assist small businesses, based in Maryland, that are unable to obtain adequate bonding on reasonable terms in the commercial marketplace. MSBDFA provides bid, payment and performance bonds for contracts funded by government agencies, regulated utilities and private entities. The penal sums of the bonds are limited to the aggregate amount of \$2,500,000 and companies may pre-qualify for multiple bonds within pre-approved terms and conditions. MSBDFA also provides lines of credit, term loans and loan guarantees to help qualified businesses purchase equipment and real property, make improvements to leased property, refinance existing debt and assist them with their working capital needs. For more information on how to apply, you may contact: Meridian Management Group, Inc. (MMG), (the Program's Manager), 826 E. Baltimore Street, Baltimore, Maryland 21202, Telephone: (410) 333-4270. Or visit their website at www.mmcapitalgroup.com for information, applications and a checklist of required documents and reports that must accompany the application.

S E C T I O N I I

SPECIAL PROVISIONS

MAINTENANCE BOND

Per the Baltimore County Department of Public Works and Transportation September 2023 Standard Specifications for Construction and Materials, Section GP – 4.10 (C) states, the contractor is required to post a maintenance bond in the amount of five (5) percent of the total cost of the contract or withhold five (5) percent retainage for two (2) years from the date of Final Acceptance.

BALTIMORE COUNTY, MARYLAND

BOND NO. _____

CONTRACT NO. _____

MAINTENANCE BOND

THIS MAINTENANCE BOND is entered into on this _____ day of _____, 20____, by and between _____, as principal ("Principal") and _____, a business entity that is authorized to transact business in the State of Maryland and is organized and existing under the laws of the State of _____, as surety ("Surety"), are held and firmly bound unto Baltimore County, Maryland, a body corporate and politic of the State of Maryland ("County"), as Obligee.

WHEREAS, the above-named Principal has entered into a written contract known as Contract Number _____ dated _____, 20____ with Obligee for _____ (the "Agreement"), the terms of which are hereby incorporated by reference; and

WHEREAS, Principal has completed construction under the Agreement; and

WHEREAS, the Agreement includes a warranty on the quality of the Work performed that runs for a period of two (2) years from the date of the County's final acceptance and that runs for two (2) additional years beyond the repair date if any repair is done during the warranty period; and

WHEREAS, Principal is required to cause this instrument to be executed and delivered to Obligee as security for maintenance during the warranty period in an amount equal to 5% of the total value of the Contract.

NOW, THEREFORE, the Principal and Surety are held and firmly bound unto the Obligee in the sum of \$ _____ Dollars (\$ _____), lawful money of the United States of America, for the payment of which sum of money the Principal and Surety do bind themselves and their personal representatives, legal representatives, successors, and assigns, jointly and severally, firmly by this maintenance bond.

The conditions of this bond are as follows:

1. The Principal shall, for a period of two (2) years from and after the date of completion and acceptance of same by Obligee, replace all defects arising in the Work, whether resulting from defective materials, equipment, design furnished or workmanship. After such period, this obligation shall be null and void; otherwise it shall remain in full force and effect.

2. In the event of a default on the part of the Principal that may be the subject of a claim under this bond, Obligee shall mail, by certified mail, to Surety at the address listed below, a written statement that a claim is being made under the bond and, with substantial accuracy, the amount of the claim. Surety shall have no obligation to Obligee under this bond until the notice of claim is mailed.
3. When the Obligee has satisfied the condition of Paragraph 2 that a notice of claim be mailed, the Surety shall promptly and at the Surety's expense send an answer to Obligee within 30 days after the date of the claim. The answer shall state the amounts that are undisputed and the basis for challenging any amounts that are disputed. The answer shall be accompanied by payment (or arrangements for immediate payment) of any undisputed amounts.
4. Surety expressly waives any right to receive notice of extensions of time or alterations or modifications to the Agreement that may be granted by Obligee and agreed upon by Principal, and any such extensions, alterations, or modifications shall not affect the obligation of the Surety under this bond.
5. This bond is a specialty governed by the twelve-year statute of limitations period set forth in the Annotated Code of Maryland Courts and Judicial Proceedings §5-102.

WITNESS OR ATTEST:

(Principal – Contractor Name)

By: _____

Type Name: _____

Type Title: _____

Date: _____

(Surety)

By: _____

Type Name: _____

Type Title: _____

Type Address: _____

Date: _____

The Contract shall be done in strict compliance with the Baltimore County Department of Public Works and Transportation September 2023 "Standard Specifications for Construction and Materials" and "Standard Details for Construction", and any and all revisions thereto as of the date of the fully executed Contract, including but not limited to the General Conditions Building Projects, as applicable, and all of which are made a part hereof and incorporated herein (collectively, the "**Specifications**"). Copies of which are available on the County's website at www.baltimorecountymd.gov/departments/public-works/standards. **IN ADDITION, THE CONTRACTOR UNDERSTANDS AND AGREES THAT THE FOLLOWING SECTIONS OF THE SPECIFICATIONS (GP-1.03 AND GP-5-15) SHALL BE STRICKEN AND THE FOLLOWING SHALL BE INSERTED IN AND INCORPORATED INTO THE CONTRACT IN LIEU THEREOF:**

GP-1.03 ORGANIZATIONAL DEFINITIONS

Administration - Baltimore County.

Administrator - The Director of the Office of Budget and Finance, Baltimore County.

Baltimore County - Baltimore County, Maryland: a body corporate and politic.

Department - The word "Department" shall mean the Office of Budget and Finance of Baltimore County.

Engineer - One of the following engineering executives:

Director of Office of Budget and Finance
Chief, Property Management Division of the Office of Budget and Finance

Any delegation of the Engineer's authority must be authorized in writing by any one of the above listed officials, and such delegation of authority will pertain only to the specific contract and/or contracts shown by the authorization. The title of the specific official will appear in those cases within these specifications where the word "Engineer" as defined herein is not sufficiently specific.

Inspector - The authorized representative of the procurement officer assigned to make detailed inspection of any or all portions of the work, or materials therefor.

Procurement Officer - See Engineer.

GP-5.15 DISPUTES

(a) Except as otherwise may be provided by applicable law or regulation, all disputes arising under or as a result of a breach of this Contract that are not disposed of by mutual agreement shall be resolved in accordance with this General Provision.

(b) As used herein, "claim" means a: written demand or assertion by one of the parties seeking, as a legal right, the payment of money, adjustment or interpretation of Contract terms, or other relief, arising under or relating to this Contract.

A voucher, invoice, or request for payment that is not in dispute when submitted is not a claim under this General Provision. However, if the submission subsequently is not acted upon in a reasonable time, or is disputed either as to liability or amount, it may be converted to a claim for the purpose of this General Provision.

- (c) When a claim cannot be resolved by mutual agreement, the Contractor shall submit a written request for decision to the Department's Chief of the Property Management Division for his decision in consultation with the County Office of Law. The Contractor's written request shall set forth all the facts surrounding the controversy, including, but not limited to, those items listed in GP-5.14(b). Any claim by the County shall be decided in like manner.
- (d) The Contractor, at the discretion of the Engineer, may be afforded an opportunity to be heard and to offer evidence in support of his claim. Pending resolution of a claim, the Contractor shall proceed diligently with the performance of the Contract.
- (e) The Department's Chief of the Property Management Division shall decide any and all claims. The decision by the Department's Chief of the Property Management Division shall be issued within ninety (90) Days on matters of less than fifty thousand dollars (\$50,000) and within one hundred eighty (180) Days on matters of fifty thousand dollars (\$50,000) or more. The written decision of the Department's Chief of the Property Management Division shall be final and binding unless appealed in writing to the Director of the Department within thirty (30) Days of the Chief's written opinion to the parties. If the Chief's decision is timely appealed in writing to the Director of the Department, the Director of the Department, serving as referee, will review the written appeal submitted to assure all reasonable attempts were made to resolve the appeal.
- (f) The Director shall issue his/her decision in writing within ninety (90) Days. The Director's decision shall be final and conclusive unless a written appeal is mailed or otherwise filed with the County Administrative Officer within thirty (30) Days of the Director's written decision.
- (g) When the County Administrative Officer is satisfied all efforts at the Department level were made to resolve the dispute, a claim shall be resolved as follows:

 - (1) Subject to, and without in any way enlarging or limiting the other provisions of the Contract, the parties to any Agreement which adopts or incorporates by reference these Standard Specifications, appoint the County Administrative Officer as an administrative hearing officer pursuant to Article 25A, "Chartered Counties of Maryland", of the Annotated Code of Maryland.
 - (2) The parties further grant the County Administrative Officer the right to delegate this responsibility and authority in writing to a County official who is a registered professional engineer, independent of the Department of Public Works and Transportation's Division of Construction Contracts Administration, or to any other County official.
 - (3) For disputes involving ten thousand dollars (\$10,000) or more the decision of the administrative hearing officer shall be final and binding on both parties, subject only to such appeals on the record as provided by Article 25A. For disputes involving less than ten thousand dollars (\$10,000), the decision of the administrative hearing officer shall be final and binding on both parties.

GENERAL CONDITIONS

BUILDING PROJECTS



**Revised September 1, 2024,
in compliance with September 2023
Standard Specifications for Construction and Materials**

INDEX GENERAL CONDITIONS BUILDING PROJECTS

	Page
I. <u>SPECIFICATIONS</u>	
Article 1 - Applicable Specifications	GC-1
II. <u>DEFINITIONS</u>	
Article 2 - Definitions	GC-1
Article 3 - Time Limits	GC-2
Article 4 - Sunday, Night & Holiday Work	GC-2
III. <u>CONTRACT DOCUMENTS & SHOP DRAWINGS</u>	
Article 5 - Contract Documents	GC-2 & 3
Article 6 - Shop Drawings	GC-4 & 5
Article 7 - Separate Contracts	GC-5 & 6
IV. <u>PAYMENT</u>	
Article 8 - Payments	GC-6
Article 9 - Approval of Payments	GC-6
Article 10 - Payment Withheld	GC-7
Article 11 - Changes in Work	GC-7 & 8
Article 12 - Claims for Extra Cost	GC-9
Article 13 - Deduction for Uncorrected Work	GC-9
Article 14 - Delays and Extension of Time	GC-9
Article 15 - Correction of Work after Final Payment	GC-9
Article 16 - Deleted	GC-9
Article 17 - Assignment	GC-9
Article 18 - Maryland State Sales Tax	GC-9 & 10
V. <u>MATERIALS</u>	
Article 19 - Materials	GC-10 & 11
VI. <u>QUALIFICATION, EMPLOYEES, WORKMANSHIP, SUBCONTRACTORS & ADVERTISING</u>	
Article 20 - Qualification of Bidders	GC-12
Article 21 - Employees and Workmanship	GC-12, 13 & 14
Article 22 - Employment Lists	GC-14
Article 23 - Contractor's Supervision	GC-14
Article 24 - The County's Right to Do Work	GC-14
Article 25 - County's Right to Terminate Contract	GC-15
Article 26 - Sanitary Conveniences	GC-16
Article 28 - Relation of Contractor and Subcontractor	GC-16, 17 & 18
Article 29 - Interlocking Contracts	GC-18
Article 30 - Advertising Signs	GC-18

VII. LAWS, PERMITS, LICENSES, INSURANCE & BONDS

Article 31 - Laws, Permits and Regulations	GC-18 & 19
Article 32 - Compensation, Liability and Property Damage Insurance	GC-19
Article 33 - Builder's Risk Insurance	GC-19 & 20
Article 34 - Guaranty Bonds	GC-20
Article 35 - Damages	GC-20

VIII. INSPECTION AND SURVEYS

Article 36 - Inspection	GC-20 & 21
Article 37 - Surveys	GC-21
Article 38 - Unauthorized Work	GC-21

IX. CONSTRUCTION

Article 39 - Construction Schedule	GC-21
Article 40 - Protection of Work and Property	GC-22
Article 41 - Shoring, Bracing and Sheeting	GC-22
Article 42 - Tests	GC-22 & 23
Article 43 - Cleaning Up	GC-23
Article 44 - As-Built Drawings	GC-23
Article 45 - Drainage and Pumping	GC-23
Article 46 - Temporary Water, Electric and Other Services	GC-23 & 24
Article 47 - Connecting to Existing Utilities	GC-24
Article 48 - Existing Utilities Shown on Plans	GC-24

X. MISCELLANEOUS ADDENDA

Article 49 - Holidays	GC-25
Article 50 - Buy American Steel	GC-25
Article 51 - Guarantee	GC-25
Article 52 - Offices and Telephones	GC-25 & 26
Project Sign	GC-27

GENERAL CONDITIONS DESIGN BUILD BUILDING PROJECTS

I. SPECIFICATIONS

Article 1 Applicable Specifications

All work performed under this Contract shall be done under strict compliance with the *Specifications* bound herewith, and with the *Baltimore County Standard Specifications for Construction and Materials* and the *Standard Details for Construction* dated September 2023 and subsequent addenda thereto, so far as the same may be applicable, copies of which are available on the County's website at www.baltimorecountymd.gov/departments/public-works/standards. These General Conditions are in addition to the aforementioned Specifications. Should there be any conflict with the aforementioned manuals, the *General Conditions* take preference.

II. DEFINITIONS

Article 2 Definitions

- A. *Architect and/or Engineer* shall mean the registered Architect and/or Engineer commissioned by the County to prepare the plans and contract documents.
- B. *Engineer* in these General Conditions and in the Construction Specifications in some instances refers to authorized representatives of the Office of Budget and Finance, Property Management.
- C. *Subcontractor*, as employed herein, includes only those having a direct contract with the Contractor. It includes one who furnished material worked to a special design according to the Plans and Specifications for the "work." It excludes one who merely furnished material not so worked.
- D. *Written Notice* shall be deemed to have been duly served if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered to or sent by registered mail to the last business address known to him who gives the notice.
- E. *Repair* means to restore after injury, deterioration, or wear; to mend, to renovate, by such means as appropriate, and to supply such materials and labor as necessary to render the item to be repaired sound, solid, true, plumb, square, even, smooth, and fully serviceable. Upon completion of such repair it must be, unless otherwise stated, rendered to such condition as to present a first-class finished work, or in instances where the repaired item serves as a base for additional finish, the repaired work must be such as to permit a first-class finish, to be applied without extra cost to the County. When the word "repair" is used in connection with machinery or mechanical equipment, it shall mean, in addition to the above, rendering the equipment completely serviceable and efficient, ready for the normal use for which it was originally intended.

- F. Some parts of the "Construction Specifications," bound herewith are of the abbreviated or "streamlined" type and includes incomplete sentences. Omissions of words or phrases such as "the Contractor shall", "in conformity therewith", "shall be", "as noted on the drawings", "according to the plans", "a", "an", "the", and "all" are intentional. Omitted words or phrases shall be supplied by inference in the same manner as they are when a "note" occurs on the drawings. Words "shall be" or "shall" will be supplied by inference when colon (:) is used within sentences or phrases.

Article 3 Time Limits

The proposal shall indicate whether the contract limit is based on Working Days or Calendar Days. If this is not indicated in the Proposal, then the time limits will be based on Calendar Days.

Article 4 Sunday, Night and Holiday Work

If Sunday, night or holiday work is necessary due to an emergency or is permitted by the Engineer, the Contractor shall secure and pay for any and all permits required in connection with this work.

III. CONTRACT DOCUMENTS AND SHOP DRAWINGS

Article 5 Contract Documents

A. Clarification

It is assumed that the Contractor has obtained clarification of all questions which may have arisen as to intent of the contract documents, or assumed, or actual conflict between two or more items in the Contract Documents as required in "Instructions to Bidders." Should the Contractor have failed to obtain such clarification as required by the "Instructions to Bidders," then the Engineer may direct the work to proceed by any method indicated, specified or required by the Contract Documents in the interest of maintaining the best construction practice. Such direction by the Engineer shall not constitute a claim for extra by the Contractor.

B. Jargon

Work described in words that have a well-known technical or trade meaning shall be held to refer to such recognized standard use.

C. Drawings

The Contractor shall do no work without proper drawings and instructions. Drawings are, in general, drawn to scale; however, symbols are used to indicate materials and structural and mechanical requirements. When symbols are used, the drawings are, of necessity, diagrammatic, as it is not possible to indicate all connections, fittings, fastenings, etc., which are included as a part of the work. Diagrammatic indication of mechanical piping, ducts, and conduit within the buildings is subject to adjustment in order to obtain proper grading, passage over, under or past obstructions, to avoid exposure in finished rooms and unsightly and obstructing conditions. The Contractor shall coordinate these adjustments.

1. Copies no longer Furnished

The County will no longer furnish the Contractor any copies of the Drawings and Specifications. Additional copies may be obtained by the Contractor downloading drawings and specifications from the Baltimore County Solicitation Web Page.

2. Copies of the Work

The Contractor shall keep in the office on the job a complete set of all drawings, specifications, shop drawings, schedules, etc., in good order and available to the Engineer and representatives of the County.

3. Ownership

All documents as furnished by the County remain the property of the County. They must not be used on other work but shall be returned to the County upon completion of the work.

D. Large Scale Detail Drawings

The Architect shall furnish, when necessary, additional instructions in the form of large scale developments of the drawings used for bidding, or to amplify Construction Specifications for the proper execution of the work. These shall be true developments of the bidding documents and reasonably inferable there from. The work shall be executed in conformity herewith. [See Article 6, Paragraph A.3.(c)]

E. Dimensions

The Contractor shall carefully check all dimensions prior to execution of the particular work affected. Whenever inaccuracies or discrepancies are found, the Contractor shall consult the Engineer prior to any construction or demolition. Should any dimensions be missing, the Engineer will be consulted and supply them prior to execution of the work. Dimensions for items to be fitted into constructed conditions at the job will be taken at the job and will be the responsibility of the Contractor. The obvious intent of the documents or obvious requirements dictated by conditions existing or being constructed supersedes dimensions or notes which may be in conflict herewith.

Whenever a stock size manufactured item or piece of equipment is specified by its nominal size, it is the responsibility of the Contractor to determine the actual space requirements for setting or entrance to the setting space. No extra will be allowed by reason of work requiring adjustment in order to accommodate the particular item of equipment.

Whenever new work, building, addition or portions thereof are not accurately located by plan dimensions, the Engineer will supply exact position prior to execution of the work.

Article 6 Shop Drawings

A. Shop Drawings (those prepared by the Contractor or Vendor of Material)

The Contractor shall submit for the Architect's approval, at such times as agreed (see Article 8), shop drawings (to include setting drawings and schedules) as required for the work of the various trades. These drawings shall be prepared in conformity with the best practice and standards for the trade concerned. Due regard shall be given to speed and economy of fabrication and erection.

1. Items to be Detailed

Shop details shall be supplied for all items which are specially fabricated for the work or when the assembly of several items is required of a working unit. Shop drawings are required for all reinforcing and structural steel, specially made or cut masonry units, miscellaneous metal work, specially made flashings or roofing and sheet metal work, specially made millwork, special rough hardware and all heating, ventilating, plumbing and electrical requiring special fabrication or detailed connections, including ducts.

2. Submissions

Shop drawings, brochures and catalog cut submissions shall consist of sufficient copies to provide for the retention by the Architect and County of five (5) copies total plus such additional copies as the Contractor may require. Drawings shall not exceed 24 in. x 36 in. in size.

3. Examination and Approval

The Contractor shall review all shop drawings, brochures and catalog cuts provided by the subcontractors and vendors prior to submitting them to the Architect. The Architect shall examine shop drawings with reasonable promptness, noting desired corrections, or granting approval.

a. Field Dimensions and Conditions

The Architect is not responsible for the checking of dimensions or existing conditions in the field. This is the sole responsibility of the Contractor.

b. Resubmission

When the Architect's notations or corrections are extensive, then the Contractor shall resubmit the drawings with changes made on the drawings.

c. Contractor's Responsibility

Unless the Contractor has in writing, notified the Architect to the contrary, at the time of submission, it will be assumed that the drawings are in conformity with the Contract Documents and do not involve any change in the Contract price or any change which will alter the space within the structure or alter the manner of operation from that contemplated in the Contract Documents.

d. Architect's Notations

Should the Contractor consider any change or notation received in compliance with paragraph (c) above as increasing the cost of the work from that contemplated in the Contract Documents, then the Contractor shall desist from further action relative to the item he/she questions and shall notify the Engineer, in writing, within five (5) days of the additional cost involved. No work shall be executed until the entire matter is cleared or a Change Order issued, or the Contractor is ordered by the Engineer to proceed under the provisions of the County's Standard Specifications. Failure of the Contractor to serve written notice, as above required, shall constitute a waiver of any claim in relation thereto.

(1) Similarly, should the Architect's notation or change involve less work than is covered by the Contract Documents, the Contractor shall allow the County the credit resulting from the change.

(2) Should the Contractor consider that any notation or change made by the Architect under provisions of this paragraph, paragraph (c), above, as involving a complete change in the subcontractor's relation or the substitution of a material different from that on which the Contract was based, then the Contractor shall act as herein stated or as in paragraph (c) above.

4. Project Completion

At the completion of the project, the Contractor shall submit a list of shop drawings for the entire project. This list shall contain the following information: title, description, specialty (Architectural, Structural, Mechanical, etc.), decision (no exceptions taken, approved, approved as noted, etc.).

Article 7 Separate Contracts

A. The County reserves the right to let other contracts in connection with paving and utilities adjoining this work. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work, and shall properly connect and coordinate his work with theirs.

- B. If any part of the Contractor's work depends for proper execution or results upon the work of any other contractor, the Contractor shall inspect and promptly report to the Engineer any defects in such work that render it unsuitable for such proper execution and results. Failure to inspect and report shall constitute an acceptance of the other contractor's work as fit and proper for the reception of the work, except as to the defects which may develop in the other contractor's work after the execution of the work.
- C. To ensure the proper execution of his/her subsequent work, the Contractor shall verify work already in place and shall at once report to the Engineer any discrepancy between the executed work and the drawings.

IV. PAYMENTS

Article 8 Payments

- A. Under this Contract payments will be made monthly on the valuation of work accomplished and on account of materials delivered on the site, for incorporation in the work, which are suitably stored.
- B. At the first of each month, the Contractor shall submit to the Engineer an application for payment on a form provided by the Engineer. Prior to application for first payment, the Contractor shall submit to the Engineer a schedule of values for the various parts of the work, including quantities, aggregating to the total sum of the Contract. This shall be so divided as to facilitate payment to subcontractors in accordance with Article 28, Paragraph C.1. The form of this submission shall be such as the Contractor or Engineer have agreed upon, and, if required, shall be supported by such evidence as to its correctness as the engineer may direct. This schedule, when approved by the Engineer, shall be used as a basis for approval of payment unless it is found to be in error. In applying for payment, the Contractor shall submit a statement based upon the schedule, itemized in such form and supported by such evidence as the Engineer may require, showing the Contractor's right to the payment claimed. If required, the Contractor shall show receipts and other vouchers for the payments for materials and labor including payments to subcontractors, as required by Article 28.
- C. Materials Purchased Under Allowance

The Engineer will provide schedules for all materials to be purchased from specified allowance.

Article 9 Approval of Payments

If the Contractor has made application, as above, the Engineer shall review and approve such payments as is decided to be properly due in accordance with the approved schedule. In approving such partial payments, there shall be retained no more than 10% of the total amount for the first 50% of the contract, after which only 5% of the total amount of the contract may be withheld unless the need is demonstrated for retaining more to protect the public interest.

Article 10 Payment Withheld

- A. The Engineer may withhold, or on account of subsequently discovered evidence, nullify the whole or a part of any payment to such extent as may be necessary to protect the County from loss on account of:
1. Defective work not remedied.
 2. Claims filed, or reasonable evidence indicating probable filing of claims, by parties other than the Contractor.
 3. Failure of the Contractor to make payments properly to subcontractors or for material or labor.
 4. A reasonable doubt that the Contract can be completed for the balance then unpaid.
 5. Damage to another Contractor.
 6. Failure of the Contractor to submit data required within the time limits stated in the Contract Documents.

Upon removal of the above, payment shall be made for the amounts withheld.

Article 11 Changes in Work

- A. The County, without invalidating the Contract, may order changes in the work by altering, adding to or deduction from the work, the Contract sum being adjusted accordingly. Such change shall be executed under these *General Conditions*. Extension of time made necessary thereby shall be adjusted at the time of such Change Order.
- B. The Engineer shall have authority to make minor changes in the work not involving extra cost and not inconsistent with the purpose of the project. Otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless a written order for the Office Budget and Finance, Property Management signed or countersigned by the Director has been received by the Contractor. No claim for addition to the Contract sum shall be valid unless so ordered.
- C. The value of any such extra work or change shall be determined in one or more of the following ways as determined by the Office of Budget and Finance, Property Management.
1. By Estimate and Acceptance of a Lump Sum
 - a. The prime Contractor shall furnish a breakdown of the estimated construction cost. The breakdown shall be of sufficient detail to describe the extra work and related costs for labor, material, overhead and profit.

b. Overhead and Profit

(1) Extra work by Subcontractor:

Subcontractor will be allowed 10% overhead and 10% profit added to the direct labor and material costs. The prime contractor will be allowed to increase the subcontractors total lump sum by 10% to cover his/her administration.

(2) Extra work by Prime Contractor:

The prime contractor will be allowed 10% overhead and 10% profit added to the labor and material costs.

c. The prime contractor will be allowed 1 % for the bond added to the labor and material costs.

d. The allowed overhead will include all supervision; no additional allowance will be made for it.

2. By Unit Prices Named in the Contract or Subsequently Agreed Upon

Such unit prices are to include all supervision, overhead, taxes, insurance and profit.

3. By Cost and a Fixed Fee

Added to the cost is a fixed fee portion which is to include supervision, overhead, insurance and profit.

4. By Force Account (Labor and Material Cost plus)

In accordance with the *Baltimore County Specifications for Construction and Materials* Section GP 9.02, the Contractor is allowed to add 65% mark-up.

D. Should none of the methods stated in Paragraph C. 1, 2, or 3 be determined, the Contractor shall, providing he/she receives an order as defined in Paragraph B, above, proceed with the work on the basis of Paragraph C. 4. Force Account.

The Contractor and Engineer shall keep accurate costs, in such form as the Engineer may direct, for presentation, together with vouchers, to the Office of Budget and Finance Property Management for determination of the value of the work included in each Change Order. Pending determination of the final value, the Engineer may include payments for materials and labor, as stated in Article 8, in monthly vouchers.

Article 12 Claims for Extra Cost

No claim for extra will be granted which includes cost of delays or work stoppage due to strikes, lockouts, fire, avoidable casualties or damage or delay in transportation for which the County or its agents are not responsible. (See also Article 14.)

Article 13 Deductions for Uncorrected Work

If the Engineer and County deem it expedient to correct work injured or done not in accordance with the Contract, an equitable deduction from the Contract price shall be made therefore.

Article 14 Delays and Extension of Time

If no schedule or agreement stating the dates upon which drawings shall be furnished is made (see Article 8), then no claim for delay shall be allowed on account of failure to furnish drawings until two (2) weeks after demand for such drawings, and then not unless such claim is reasonable.

Article 15 Correction of Work After Final Payment

Neither the final certificate nor payment nor any provision in the Contract Documents shall relieve the Contractor of responsibility for faulty materials and workmanship. Unless otherwise specified, the Contractor shall remedy any defects and pay for any damage to other work resulting there from that appears within the guarantee period. The County shall give notice of observed defects with reasonable promptness. All questions arising under this Article shall be decided by the Director of Budget and Finance, Property Management.

Article 16 (Deleted)

Article 17 Assignment

The Contractor shall not assign the Contract. It shall not be sublet as a whole or sublet by trades or other portions in an amount of more than 75% of the monetary value of the Contract. The remaining 25% shall be executed by the Contractor with labor and materials directly purchased and paid for by the Contractor. Costs for insurance, over-head, supervisions, etc., may not be claimed as a portion of the 25% mentioned above. The execution of work by a subsidiary of the Contractor is not considered direct employment. The Contractor shall not assign any monies due or to become due to him/her hereunder, without the previous written consent of the County.

Article 18 Maryland State Sales Tax

- A. Contractors who are performing work for the State of Maryland or any of its political subdivisions are required to pay tax on materials and supplies which will be incorporated into the work.

- B. The Contractor must pay the tax on all equipment which is purchased, Even though it may be used on a job for the State of any of its political subdivisions.

V. MATERIALS

Article 19 Materials

Materials include all manufactured products and processed and unprocessed natural substances required for completion of the Contract. The Contractor in accepting the Contract is assumed to be thoroughly familiar with the materials required and their limitations as to use and requirements for connections, setting, maintenance and operation.

Whenever an article, material or equipment is specified and a fastening, furring, connection (including utility connections), bed or accessory is normally considered essential to its installation in good quality construction, such shall be included as if fully specified. Nothing in the Construction Specifications shall be interpreted as authorizing any work in any manner contrary to applicable law, codes or regulations (See Article 31).

A. Approval

All materials are subject to the Architect's or Engineer's approval as to conformity with the specifications, quality, design, color, etc. No work for which approval is necessary shall be contracted for, or used, until written approval is given by the Architect or Engineer. Approval of a subcontractor, as such, does not constitute approval of a material which is other than that included in the Construction Specifications.

B. New Materials

Unless otherwise specified, all materials shall be new.

C. Quality

Unless otherwise specified, all material shall be of the best quality of the respective kinds.

D. Samples

The Contractor shall furnish for approval all samples as directed. The work shall be the same as the approved samples.

E. Painting and Color

The Architect and Contractor shall jointly prepare the paint and color schedules. The Architect shall direct the exact color, texture and finish.

F. Proof of Quality

The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of materials either before or after installation. The Contractor shall pay for any tests as may be deemed necessary in relation to "Substitutions" (Paragraph I. below).

G. Contractor's Option

When several products or manufacturers are named in the Construction Specifications for the same purpose or use, then the Contractor shall select any of those so named. However, all of the units of a thing required for a project must be the same in material and manufacture.

H. "Or Equal", "Equal", "Approved Equal"

The above terms are used as synonyms throughout the Construction Specifications. They are implied in reference to all named manufacturers. Only materials that, in the opinion of the Engineer, are fully equal in all details of construction, methods of assembly, finish and design quality will be considered. (See A, C, E, above, and I. below.)

I. Substitutions

Should the Contractor desire to substitute another material for one or more specified by name, the Contractor shall apply, in writing, for such permission and state the credit or extra involved by the use of such material. The Engineer will not consider the substitution of any material different in type or construction methods unless such substitution effects a benefit to the County. (See A. and D. above.)

The Contractor shall not submit for approval, materials other than those specified without a written statement why such a Substitution is proposed. Approval of a "substitute" material by the Architect or Engineer when the Contractor has not designated such material is a "substitute," shall not be binding on the County nor release the Contractor from any obligations of the Contract, unless the Architect or Engineer approves such "substitutions" in writing.

J. Standard Specifications

Whenever references are made in the Contract Documents to the *Baltimore County Standard Specifications for Construction and Materials* and *Standard Details for Construction*, it shall be understood that the latest standards and/or requirements are intended and shall apply. When no specification is cited and the quality, processing, composition or method of installation of a thing is only generally referred to then:

1. For things not otherwise specified below, the latest edition of the Applicable American Society for Testing Materials Specifications shall apply.

2. For things covered by the applicable portions, the National Bureau of Fire Underwriters Code shall apply.
3. For things generally considered as plumbing and those things requiring plumbing connections, the applicable portions of the latest edition of the American Society of Mechanical Engineers Code and the Baltimore County Plumbing Code shall apply.
4. For things generally considered as heating and ventilating work and not covered by A.S.M.E. Code, the applicable portions of the latest edition of the Heating and Ventilating Guide, published by the American Society of Heating and Ventilating Engineers, and the Baltimore County Building Code shall apply.

K. Storage

The contractor shall confine apparatus and storage of materials to the "off-road" area delineated as the "Limit of Contract." The Contractor shall not load or permit any part of the structure to be loaded with a weight that will endanger the safety of the structure or any part thereof.

VI. QUALIFICATION, EMPLOYEES, WORKMANSHIP, SUBCONTRACTORS AND ADVERTISING

Article 20 Qualification of Bidders

Bidders are required to be prequalified 10 days prior to bid opening, satisfactorily evidencing that they have the ability, equipment, organization and financial resources sufficient to enable completion of the work satisfactorily within the time specified in the Proposal.

Article 21 Employees and Workmanship

A. Employees

1. Qualification

Only personnel thoroughly trained and skilled in the task assigned them may be employed on any portion of the work, or they shall be removed.

2. Licensed

When County, State or Federal laws require that certain personnel (electricians, plumbers, etc.) be licensed, then all such personnel employed on the work shall be so licensed.

B. Quality of Labor

The Contractor shall employ on the work, at all times, sufficient personnel to complete the work within the time stated in the Proposal.

C. Work Areas

The Contractor shall confine the operations of his/her employees to the limits as provided by law, ordinance, permits or directions of the Office of Budget and Finance Property Management. Generally, the "off-road" area will be the same as the "limit of Contract" line.

D. Methods and Quality

1. All workmanship shall be of good quality. Whenever the method of the work or manner of procedure is not specifically stated or shown in the Contract Documents, then it is intended that the best standard practice shall be adhered to. Recommendations of the manufacturers of approved materials shall be considered as a part of Construction Specifications and all materials shall be applied, installed, connected, erected, used, cleaned and conditioned as so called for thereby. This, however, does not remove any requirement in Construction Specifications to add to the manufacturer's recommendations.
2. All materials shall be accurately assembled, set, etc., and when so required in good construction, shall be true to line, even, square, plumb, level and regularly spaced, coursed, etc. Under no circumstances, either in new or old work, shall any material be applied over another which has not been thoroughly cleaned, sanded or otherwise treated so as not to impair the finish, adhesion, or efficiency of the next applied item.
3. All methods, procedures and results are subject to the Engineer's approval as to finished result to be obtained. However, this is not to be interpreted as placing upon the Engineer any responsibility for the "work" management which is solely the responsibility of the Contractor.

E. Joining of Work

1. The Contractor shall so schedule the work as to ensure efficient and uninterrupted progress and to hold to an absolute minimum the cutting and patching of new work. All cutting, patching and digging necessary to the execution of the work is included.
2. The Contractor shall so schedule (to include subcontracts) the construction performed by each group or trade that each installation or portion of the construction shall member with and join with all other work as required for a complete installation, all according to accepted good construction practice.

F. Superintendent

The Contractor shall keep on the work, at all times during its progress, a competent superintendent and all necessary assistants, all approved by the

Office of Budget and Finance Property Management. Prior to commencement of the work, the Contractor shall submit in writing to the Office of Budget and Finance Property Management the name and qualifications of the person to be employed as Superintendent for the execution of the Contract. A written approval or rejection will be given following review of the data. Persons who have previously proved unsatisfactory on work executed for the County, or who are without proper qualifications, will not be approved. Should the Superintendent be complained of by the Office of Budget and Finance Property Management for cause, he/she shall be removed from the work. Should it be necessary to change the Superintendent, the above procedure shall be repeated. The Superintendent will represent the Contractor. All directions given to the Superintendent shall be as binding as if given to the Contractor. Important directions shall be confirmed on written request in each case.

G. Discipline

The Contractor shall at all times enforce strict discipline and good order among his/her employees and shall not employ or permit to remain on the work any unfit person. The Contractor shall enforce all instructions relative to use of water, heat, power, no smoking, and control any use of fires, as required by law and for the Office of Budget and Finance Property Management. Employees must not be allowed to loiter on the premises before or after job working hours.

Article 22 Employment Lists

The Contractor may contact MARYLAND STATE EMPLOYMENT SERVICE, Towson, MD, 21204, if so desired, for additional labor regarding this project.

Article 23 Contractor's Supervision (Also see Article 21, Paragraph F.)

The Contractor shall constantly maintain efficient supervision of the work, using his/her best skills and coordinating ability. The Contractor shall carefully study and compare all drawings, specifications, and other instructions and check them against conditions existing or being constructed on the project. The Contractor shall report to the Engineer any error inconsistency or omission which may be discovered. (See also Article 5, Paragraph E, and Instructions to Bidders.) The Contractor shall not be held responsible for the existence or discovery of such errors or conflicts and neither shall the adjustment of such errors or conflicts be grounds for claim for extra on the art of the Contractor unless such adjustment involves work not obviously contemplated by the Contract Documents or necessary to progress of the work. The Contractor shall be responsible for the coordination of the work of all subcontractors.

Article 24 The County's Right to do Work

If the Contractor should neglect to prosecute the work properly or fail to perform any provision of this Contract, the County after three days' written notice to the Contractor may, without prejudice to any other remedy, make good such deficiencies and may deduct the cost thereof from the payment then or thereafter due the Contractor.

Article 25 County's Right to Terminate Contract

A. Terminate Contract

The Office of Budget and Finance, Property Management, upon proof that sufficient cause exists to satisfy such action, may without prejudice to any other right or remedy, and after giving the Contractor seven (7) days' written notice, terminate the employment of the Contractor and take possession of the premises and of all materials, tools, and appliances thereon and finish the work by whatever method may be deemed expedient, if any of the following conditions exists:

1. If the contractor should
 - a. Be adjudged a bankrupt or make a general assignment for the benefit of creditors,
 - b. Has a receiver appointed on account of insolvency.
 - c. Fails to or repeatedly and persistently refuses to supply properly skilled workers or proper materials, except in cases for which extension of time is provided,
 - d. Fails to make payment to subcontractors, or for materials and labor,
 - e. Persistently disregards laws, ordinances or the instructions of the Engineer, or
 - f. Is otherwise guilty of a substantial violation of any provision of the Contract.

2. Payment Status

In cases such as identified above, the Contractor shall not be entitled to receive any further payment until the work is finished. If the unpaid balance of the Contract price shall exceed the expenses of finishing the work, including compensation for additional managerial and administrative services, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the contractor shall pay the difference to the County. The expense incurred by the County as herein provided, and the damage incurred through the Contractor's default, shall be itemized by the Engineer and a certified copy supplied to the Contractor.

Article 26 Sanitary Conveniences

- A. The Contractor shall arrange for the erection and Maintenance of temporary toilets equipped with running water and drain connection for use of employees. These conveniences shall be erected and kept clean and in good condition, as required by law, until ordered removed by the Engineer.
- B. In lieu of A. above, the Contractor may install a portable approved chemical toilet at an approved location.
- C. The permanent plumbing fixtures to be constructed under this Contract shall not be used during construction, under any circumstances.

Article 27 Subcontracts Deleted

Article 28 Relation of Contractor and Subcontractor

- A. **The Contractor agrees** to bind every subcontractor and every subcontractor agrees to be bound by the terms of the Agreement, *Baltimore County's Standard Specifications for Construction and Materials* and *Standard Details for Construction the General Conditions*, the Drawings and Construction Specifications, as far as applicable, to his/her work, including the following provisions of this Article, unless specifically noted to the contrary in the subcontract approved in writing as adequate by the Office of Budget and Finance, Property Management.
- B. **The Subcontractor agrees** to be bound to the Contractor by the terms of the Agreement, *Baltimore County's Standard Specifications for Construction and Materials* and *Standard Details for Construction, General Conditions*, Special Provisions, Construction Specifications, and to assume towards him/her all obligations and responsibilities that he/she, by those documents, assumes towards the County.
 - 1. To submit to the Contractor applications for payment in such reasonable times as to enable the Contractor to apply for payment under Article 8 of these *General Conditions*.
 - 2. To make all claims for extras, for extensions of time and for damages for delays or otherwise, to the Contractor in the manner provided in *Baltimore County's Standard Specifications for Construction and Materials* or those *General Conditions* for like claims by the Contractor upon the County, except that the time for making claims for extra cost is one (1) week.

C. **The Contractor agrees** to be bound to the Subcontractor by all the obligations the County assumes to the Contractor under Agreement, *Baltimore County's Standard Specifications for Construction and Materials, General Conditions*, Drawings and Construction Specifications, and by all the provisions thereof affording remedies and redress to the Contractor from the County.

1. To pay the Subcontractors:

- a. Upon receipt of payment, if issued under the schedule of values described in *Baltimore County's Standard Specifications for Construction and Materials, G.P.- 9.03* or Article 8 of these *General Conditions*, the amount allowed to the Contractor on account of the Subcontractor's work, to the extent of the Subcontractor's interest herein.
 - b. Upon the receipt of payment, if issued otherwise than as in Paragraph C.1., above, so that at all times the total payments shall be as large in proportion to the value of the work done by him as the total amount certified to the Contractor is to the value of the work done by him/her.
 - c. To such extent as may be provided by the Contract Documents or the subcontract, if either of these provides for earlier or larger payments than the above.
 - d. On demand for his/her work or materials as far as executed and fixed in place, less the retained percentage, at the time the payment is requested, even though the Engineer fails to approve it for any cause not the fault of the Subcontractor.
 - e. A just share of any fire insurance money received by him/her, the Contractor, under Article 35 of these *General Conditions*.
2. To make no demand for liquidated damages or penalty for delay in any sum in excess of such amount as may be specified in the subcontract.
3. That no claim for services rendered or materials furnished by the Contractor to the Subcontractor shall be valid unless written notice thereof is given by the Contractor to the Subcontractor during the first ten (10) days of the calendar month following that in which the claim was originated.
4. To give the Subcontractor an opportunity to be present and to submit evidence in any manner involving his/her rights.

5. The Contractor and the Subcontractor agree that nothing in this Article shall create any obligation on the part of the County to pay to or to see to the payment of any sums to any Subcontractor.

Article 29 Interlocking Contracts

The attention of the Contractor and all Subcontractors is specifically called to the necessity of reading the Specifications covering items of the work which connect with or are dependent upon the work specified under each heading, and each Contractor executing the work called for there under shall be responsible for arranging for proper provision for connecting and coordinating his/her work with such other items.

Article 30 Advertising Signs

- A. The Contractor will furnish, erect and maintain a project sign for the duration of the project. The sign shall be placed on the site where and as directed by the Engineer. The sign shall be fastened to three posts spaced 4' apart. The posts shall be 4" x4", seven feet above ground and three feet below ground.
- B. The project sign is shown on page GC-27 in this book.

VII. LAWS, PERMITS, LICENSES, INSURANCE, AND BONDS

Article 31 Laws, Permits and Regulations

- A. Permit and Service Connections:
 1. **BUILDING PERMIT** - The County will obtain the building permit at no cost to the Contractor.
 2. **PERMANENT WATER SERVICE** - The County will apply for the water service and pay all related charges; i.e., water meter, water systems connection charge, water distribution charge and sewer systems connection charge. Total installation of the permanent water service is part of this Contract. Water service shall be installed by a County Prequalified Utility Contractor.
 3. **PLUMBING PERMIT** - The Contractor shall apply for the Permit; however, the County will pay all related charges and fees.
 4. **PERMANENT ELECTRIC SERVICE** - The Contractor shall apply for and pay for the electrical permit. The County shall obtain BGE permanent gas and electric service to the site at no cost to the Contractor.

The Contractor shall coordinate the installation of permanent gas and electric service with Baltimore Gas & Electric

Company. Both the gas and electric services shall be activated at the same time under one account number showing Baltimore County as owner. The Contractor shall be responsible for payment of consumption charges for the use of gas and electric energy obtained through the permanent service until the building is accepted by the County or until agreed upon by the County in direct coordination with the Building Services Division of Baltimore County. Charges from BGE for removal of existing electric service will be paid by the County.

5. **PERMANENT TELEPHONE SERVICE** - The County shall pay for the telephone service and systems to and in the building. The Contractor is responsible for supplying and installing all conduit, cables and junction boxes as shown on the drawings or called out in the Specifications.
 6. **CABLE** - The County shall pay for any cable television service into the building. The contractor is responsible for supplying and installing the remaining work as shown on the drawings and called out in the Specifications.
 7. **TEMPORARY SERVICES** -All temporary services, such as water, electric, telephone, etc., shall be the Contractor's entire responsibility. (Also see Article 46.)
 8. **MISCELLANEOUS PERMITS** - The Contractor shall procure any and all necessary permits not previously mentioned and pay any and all related charges and fees required and incidental to the due and lawful prosecution of the work.
- B. The Contractor shall give all notices and comply with all State and Federal laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the Drawing and Contract Specifications are at variance therewith, he/she shall promptly notify the Engineer, in writing, and any necessary changes shall be adjusted as provided in the Contract for changes in the work. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without such notice to the Engineer, he/she shall bear all costs arising there from.

Article 32 Compensation, Liability, and Property Damage Insurance

(See Insurance Provision in Part VI of this Contract.)

Article 33 Builder's Risk Insurance

- A. The Contractor shall, at his/her own cost, insure the work and keep it insured at all times during the period of construction, and until final acceptance of it by the County, against loss or damage covered by

an "All Risk" Builders Risk type of policy. The amount of insurance shall be the 100% estimated replacement cost of the work.

- B. The policies shall be made payable to the County and the Contractor, as their interest may appear, and the policies shall be left in the possession of the Engineer, prior to the start of construction.

Article 34 Guaranty Bonds

- A. Prior to signing of the Contract, the Contractor will be required to furnish bond covering the faithful performance of the Contract and the payment of all obligations arising there under, in such form as the County may prescribe with such sureties as the County may approve. The premiums shall be paid by the Contractor.
- B. The Bond to be in the amount of the total Contract price.
- C. At the direction of the Office of Budget and Finance, Property Management, the Contractor may be required to increase the above bond. Such addition will be paid for by the County in the amount of actual cost to the Contractor.

Article 35 Damages

- A. If either party to this Contract should suffer damages in any manner because of the wrongful act or neglect of the other party or of anyone employed by him/her, then reimbursement shall be made by the other party for such damage.
- B. Claims under this clause shall be made in writing to the party liable within a reasonable time at the first observance of such damage and not later than the time of final payment, except as expressly stipulated otherwise in the case of faulty work or materials, and shall be adjusted by agreement.
- C. Should the Contractor cause damage to any separate contractor on the work, the Contractor agrees, upon due notice, to settle with such contractor by agreement or refer the matter to the Office of Budget and Finance, Property Management, who will render a decision after hearing all evidence in the matter. The Contractor shall pay or satisfy such decision.

VIII. INSPECTION AND SURVEYS

Article 36 Inspection

- A. If the Construction Specifications, the Engineer's instructions, laws, ordinances, or any public authority require any work to be specially tested or approved, the Contractor shall give the Engineer timely notice of its readiness for inspection, and if the inspection is by another authority, the date fixed for such inspection. Inspections by

the Engineer shall be made promptly, and where practicable, at the source of supply. Any work covered without approval of the Engineer must, if required, be uncovered for examination at the Contractor's expense.

- B. If initial tests and/or inspections show substandard products, materials, workmanship, etc. and the Contractor elects, with the Engineer's approval, to perform additional tests and/or inspections to prove the acceptability of the substandard products, materials, workmanship etc., he/she shall perform same at his/her expense.

Article 37 Surveys

- A. The General Contractor shall, at his/her own expense, employ a registered surveyor to provide Elevation Bench Mark, and locate corners of the building and the limits of contract.
- B. The General Contractor shall, at his/her own expense, employ a competent field engineer, to give the lines and levels for the building, sidewalks and footings, etc. The Contractor will be responsible for all lines and levels and will guarantee all lines and levels as are shown on drawings.

Article 38 Unauthorized Work

Work done without lines and grades being established, work done beyond the lines and grades shown on the Plans or as established, except as herein provided, or any extra work done without written authority will be considered as unauthorized and at the expense of the Contractor and will not be measured by the Engineer, or paid for by the County. Work so done may be ordered by the Engineer to be removed and replaced at the Contractor's expense.

IX. CONSTRUCTION

Article 39 Construction Schedule

The Contractor shall hold bi-weekly "progress meetings" at the site, at a time suitable to the Engineer, at which the progress of the work shall be reported upon in detail with reference to schedules. Each interested subcontractor shall be required to have present a competent representative to report the condition of his/her branch of the work and to receive instructions. Minutes of these "progress meetings" shall be taken by the Contractor who shall type them for distribution to members of the conference, the Office of Budget and Finance, Property Management, and other interested persons. These minutes shall be received by all parties prior to the next scheduled "progress meeting."

Article 40 Protection of Work and Property

- A. All trees along the way of access shall be boxed, also all trees surrounding the building which are liable to injury by the moving, storing and working up of materials. No permanent tree shall be used for attachment of any ropes or derricks. Every public way, catch basin, conduit, tree, fence or things injured in carrying out this Contract, shall be replaced and put in good condition, unless the same shall be permanently done away with by order of the Engineer.
- B. The Contractor shall erect and properly maintain at all times as required by the conditions and progress of the work, all necessary safeguards for the protection of workers and the public and shall post danger signs warning against the hazards created by such features of construction as protruding nails, hod hoists, well holes, elevator hatchways, scaffolding, window openings, stairways and falling material.
- C. In an emergency affecting the safety of life, or of the work, or of the adjoining property, the contractor, without special instruction or authorization is hereby permitted to act, at his/her discretion, to prevent such threatened loss or injury, and he/she shall so act, without appeal, if so instructed or authorized. Any compensation claimed by the Contractor on account of emergency work shall be determined as outlined in Article 11.

Article 41 Shoring, Bracing and Sheeting

- A. The Contractor shall do all necessary shoring, bracing and sheeting required, or as directed by the Engineer, to carryout the work, install the foundations and other building construction, to protect the street, sidewalks and all adjoining buildings and property. He/she shall thoroughly brace and protect all earth banks sides of pits, trenches, and other excavations to prevent danger to persons or structures, and to prevent injurious cavings or erosion of any sort. Shoring and sheeting shall be removed after, or as, the walls are built and properly set.
- B. Full responsibility for both the design (by an Engineer licensed in Maryland) and the execution of all shoring, bracing, and sheeting work shall rest upon the contractor. While the Engineer shall be fully advised of all details for such work before the work itself is executed, this shall not in any way relieve the Contractor for full responsibility for all damage or expense arising from faulty installation of the said work of shoring, bracing, or sheeting.

Article 42 Tests

- A. Soils testing shall be performed by an independent testing firm arranged and paid for by the County.

- B. Materials testing shall be performed by an independent testing firm, paid for by the Contractor, which has previously been approved by the County and Architect/Engineer. Certified copies of all such test reports shall be submitted to the Engineer for approval.

Article 43 Cleaning Up

- A. The Contractor shall at all times keep the premises free from accumulations of waste material or rubbish caused by his/her employees or work, and at the completion of the work, shall remove all his/her rubbish from and about the project site, and all his/her tools, scaffolding and surplus material.

In case of dispute, the County may remove the rubbish and charge the cost to the several contractors as the Engineer shall determine to be just.

- B. All debris shall be kept sprinkled to reduce dust and shall be promptly removed from the building, and no combustible materials shall be stored against perimeter walls.
- C. The Contractor shall clean entirely the building as it is completed, wash all windows, scrub all floors at least once, and leave all floors free from spots and blemishes. The interior of the building and the project area shall be left "broom clean," or its equivalent.

Article 44 As-Built Drawings

The Contractor shall, as the project progresses, neatly record on a set of white prints any changes and all revisions to the work wherever they shall differ from the Contract Drawings. Upon completion of the work, the Contractor shall turn over to the Architect this set of prints.

Article 45 Drainage and Pumping

The Contractor shall remove all water, including rain water, encountered during the entire progress of the work, using pumps, drains or other methods approved by the Engineer. Excavations and the project site shall be kept free from water until all backfilling is completed. The water shall be discharged to catch basins, or other drainage points as directed by the Engineer.

Article 46 Temporary Water, Electric and Other Services

- A. The Contractor shall arrange for and pay for the installation of temporary connection to the County's water mains, including all incidental fees and expenses for water supply during construction of the project, and shall pay for all water used. Wasting of County water will not be permitted.

- B. The Contractor shall arrange for and pay for temporary electric light and power service required during construction of the project, and shall pay for all electricity used. Gasoline or other torches for lighting will not be permitted.
- C. The Contractor shall provide and pay for any other temporary services which may be required for the satisfactory completion of the project.
- D. The Contractor shall provide, at his/her own expense, all cold weather protection, temporary heat and fuel as necessary to carry on the work expeditiously during inclement weather, to protect work and materials against injury from dampness and cold, to dry out the building and provide suitable working conditions. Refer to other sections for temperatures required for work under the various trades

The methods of heating and type of fuel and equipment used shall be subject to approval by Engineer.

With special permission, in writing, permanent heating system may be used to dry out building and provide suitable working conditions in all or various parts thereof as soon as practicable. If used, Contractor shall be responsible for use of permanent heating system for purpose described and all costs of fuel, attendance, etc. in connection therewith shall be borne by him/her. Such use shall not relieve Contractor of his/her responsibility to turn over system to Owner in perfect condition on completion of project, including the removal of all dust of construction from air handling units, etc., the replacing of all filters, etc., nor shall it shorten stipulated guarantee period which will commence upon the date of final acceptance of the work.

Article 47 Connecting to Existing Utilities

The Contractor shall, at his/her own cost and expense and as part of this work under the Contract, furnish all labor, materials, tools, and appliances, and do all work required for making connections to existing storm drains, sanitary sewer, water, gas and electric service connections, as shown on drawings, and the cost of making such connections shall be included in his/her bid.

Article 48 Existing Utilities Shown on Plans

Water mains, gas mains, storm drains, sanitary sewers, and other utilities are shown on the Plans, in accordance with the best information available, for the information of the Contractor. The County assumes no responsibility for accuracy or completeness of the information shown. Existing mains and services shall be carefully protected and any damage to them caused by the work shall be immediately repaired to the satisfaction of the Engineer by the Contractor at his own expense, using materials of the quality and kinds damaged.

X. MISCELLANEOUS ADDENDA

Article 49 Holidays

The word "holidays" used in these Contract Documents shall be taken to mean the below listed holidays, which in Baltimore County, occur as shown below:

January 1	New Year's Day
3rd Monday in January	Martin Luther King's Birthday
3rd Monday in February	President's Day
4th Monday in May	Memorial Day
June 19	Juneteenth Independence
July 4	Independence Day
1st Monday in September	Labor Day
2nd Monday in October	Indigenous Peoples' Day
November 11	Veteran's Day
4th Thursday in November	Thanksgiving Day
December 25	Christmas
All Days of General Elections	

If any holiday occurs on Sunday, the following Monday shall be considered a holiday. If the holiday occurs on Saturday, the Friday immediately preceding shall be considered a holiday.

Article 50 Buy American Steel Act

The State of Maryland has approved House Bill No. 1659 to "Buy American Steel" for all Public Works projects in the State of Maryland, effective July 1, 1978. Compliance with Article 20.17 Metal Pipe (Page 100) and Article 20.18 Metal for Structures (Page 102) in the *S.H.A. Specifications for Materials, Highways, Bridges and Incidental Structures* dated March 1968 will satisfy this condition. Also see *Baltimore County's Standard Specifications for Construction and Materials* Section GP 7.28.

Article 51 Guarantee

- A. The Contractor guarantees all work against faulty or imperfect materials, against all imperfect or careless and/or unskilled workmanship, against all leaks and against all mechanical and electrical failure of equipment for a period of two (2) years from the date of acceptance of the project by the County. See other Sections of this Specification for other guarantees.
- B. The Contractor shall remove, replace or re-execute, without cost to the Owner, any work found to be imperfect during the guarantee period.

Article 52 Offices and Telephones

- A. The Contractor shall erect and maintain upon the project site, and where directed by the Engineer, suitable offices for his/her own use and that of the Engineer.

- B. A room of adequate size shall be provided and maintained in the Contractor's office to be used for "Progress Meetings," which frequently involve fifteen (15 or more persons). This space shall be so arranged that they can be held without interference with or from the other office or supervisory work. The room shall be 300 sq. ft. minimum and 10 ft. minimum width.

These offices shall be provided with adequate heating and lighting, all at the expense of the Contractor. In addition to the above requirements, air-conditioning will be required, the cost of which is to be included in the lump sum bid price. The system must be capable of maintaining a temperature of 80 degrees F dry bulb and approximately 50% relative humidity in the conditioned area when outside temperatures are 95 degrees F dry bulb and 78 degrees F wet bulb.

- C. The Engineer's office shall meet or exceed all requirements for a Type 1 office in accordance with *Baltimore County's Standard Specifications for Construction and Materials*, Section 103 Engineer's Office.

The Contractor shall provide telephone and FAX service in the Office of the Engineer. The Contractor shall pay all costs of installation and all charges for local and Baltimore City calls, but will not be expected to pay for long distance calls made from the Engineer's Office.



SECTION 000110 – TABLE OF CONTENTS

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

Section 000110	Table of Contents
Section 000150	Index of Drawings

DIVISION 01 – GENERAL REQUIREMENTS

Section 011000	Summary
Section 012500	Substitution Procedure
Section 012600	Contract Modification Procedures
Section 012900	Payment Procedures
Section 013100	Project Management & Coordination
Section 013200	Construction Progress Documentation
Section 013233	Photographic Documentation
Section 013300	Submittal Procedures
Section 014000	Quality Requirements
Section 014200	References
Section 015000	Temporary Facilities and Controls
Section 016000	Product Requirements
Section 017300	Execution
Section 017419	Construction Waste Management and Disposal
Section 017700	Closeout Procedures
Section 017823	Operation and Maintenance Documents
Section 017839	Project Record Documents
Section 017900	Demonstration and Training
Section 019113	General Commissioning Requirements

DIVISION 02 – EXISTING CONDITIONS

Section 024119	Selective Demolition
----------------	----------------------

DIVISION 04 – Masonry

Section 042000	Unit Masonry
----------------	--------------

DIVISION 05 – STEEL

Section 051200	Structural Steel Framing
----------------	--------------------------

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITS

Section 061053	Miscellaneous Rough Carpentry
----------------	-------------------------------

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

Section 072200	Roof Deck Insulation
Section 075113	Built-Up Asphalt Roofing
Section 076200	Sheet Metal Flashing and Trim
Section 077200	Roof Accessories
Section 078413	Through-Penetration Firestop Systems
Section 078446	Fire-Resistive Joint Systems
Section 079200	Joint Sealants

DIVISION 08 – OPENINGS

Section 081113	Hollow Metal Doors and Frames
Section 087100	Door Hardware
Section 089100	Aluminum Louvers

DIVISION 09 – FINISHES

Section 092216	Non-Structural Metal Framing
Section 092900	Gypsum Board
Section 095113	Acoustical Panel ceiling
Section 096513	Resilient Base & Accessories
Section 099113	Exterior Painting
Section 099123	Interior Painting

DIVISION 22 – PLUMBING

Section 220500	Common Work Results for Plumbing
Section 220523	General Duty Valves for Plumbing Piping
Section 220529	Hangers and Supports for Plumbing Piping and Equipment
Section 220553	Identification for Plumbing Piping and Equipment
Section 220719	Plumbing Piping Insulation
Section 221414	Storm Drainage Piping
Section 221423	Storm Drainage Piping Specialties

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

Section 230500	Common Work Results for HVAC
Section 230529	Hangers and Supports for HVAC Piping and Equipment
Section 230548.13	Vibration Controls for HVAC
Section 230553	Identification for HVAC Piping and Equipment
Section 230593	Testing, Adjusting and Balancing for HVAC
Section 230713	Duct Insulation
Section 230719	HVAC Piping Insulation
Section 230800	Commissioning of HVAC and HVAC Control Systems
Section 230923	Direct Digital Control (DDC) System for HVAC
Section 230923.12	Control Dampers
Section 230923.16	Gas Instruments
Section 230923.23	Pressure Instruments
Section 232123	Hydronic Pumps
Section 232300	Refrigerant Piping

Section 233113	Metal Ducts
Section 233300	Air Duct Accessories
Section 233346	Flexible Ducts
Section 233413	Fans
Section 233600	Air Terminal Units
Section 233713.13	Air Diffusers
Section 233713.23	Registers and Grilles
Section 235123	Gas Vents
Section 237433	Dedicated Outdoor-Air Units
Section 238129	Variable-Refrigerant -Flow HVAC Systems
Section 238233	Convectors
Section 238239.16	Propeller Unit Heaters

DIVISION 26 – ELECTRICAL

Section 260050	Common Work Results for Electrical
Section 260519	Low-Voltage Electrical Power Conductors and Cables
Section 260526	Grounding and Bonding for Electrical Systems
Section 260529	Hangers and Supports for Electrical Systems
Section 260533.13	Conduits for Electrical Systems
Section 260533.16	Boxes and Covers for Electrical Systems
Section 260544	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
Section 260553	Identification for Electrical Systems
Section 260573	Power Studies
Section 262213	Low Voltage Distribution Transformers
Section 262416	Panelboards
Section 262726	Wiring Devices
Section 262813	Fuses
Section 262816	Enclosed Switches and Circuit Breakers
Section 262913.03	Manual and Magnetic Motor Controllers
Section 265000	Lighting

DIVISION 28 – FIRE ALARM

Section 280513	Fire Alarm Cables and Conductors
Section 284621	Addressable Fire-Alarm System

END OF SECTION 000110

SECTION 000150 – INDEX OF DRAWINGS

GENERAL

G-1	GENERAL COVER SHEET
G-2	CODE REVIEW
G-3	PHASING PLAN

ARCHITECTURAL

A-1	FIRST FLOOR PLAN -AREA A -DEMOLITION
A-2	FIRST FLOOR PLAN -AREA B -DEMOLITION
A-3	FIRST FLOOR REFLECTED CEILING PLAN -AREA A -DEMOLITION
A-4	FIRST FLOOR REFLECTED CEILING PLAN -AREA B -DEMOLITION
A-5	ROOF PLAN -AREA A -DEMOLITION
A-6	ROOF PLAN -AREA B -DEMOLITION
A-7	FIRST FLOOR PLAN -AREA A
A-8	FIRST FLOOR PLAN -AREA B
A-9	FIRST FLOOR REFLECTED CEILING PLAN -AREA A
A-10	FIRST FLOOR REFLECTED CEILING PLAN -AREA B
A-11	ROOF PLAN -AREA A
A-12	ROOF PLAN -AREA B
A-13	ROOF SCREEN VIEWS
A-14	ROOF DETAILS
A-15	ROOF DETAILS
A-16	SCHEDULES

STRUCTURAL

S-1	STRUCTURAL NOTES
S-2	ROOF PLAN
S-3	STRUCTURAL DETAILS
S-4	STRUCTURAL DETAILS

MECHANICAL

M-1	MECHANICAL COVER SHEET
M-2	FIRST FLOOR PLAN -AREA A -DUCTWORK -DEMOLITION
M-3	FIRST FLOOR PLAN -AREA B -DUCTWORK -DEMOLITION
M-4	ENLARGED PLANS -DUCTWORK -DEMOLITION
M-5	FIRST FLOOR PLAN -AREA A -MECHANICAL PIPING -DEMOLITION
M-6	FIRST FLOOR PLAN -AREA B -MECHANICAL PIPING -DEMOLITION
M-7	ENLARGED PLANS -MECHANICAL PIPING -DEMOLITION
M-8	ROOF PLAN -AREA A -MECHANICAL -DEMOLITION
M-9	ROOF PLAN -AREA B -MECHANICAL -DEMOLITION
M-10	FIRST FLOOR PLAN -AREA A -DUCTWORK -NEW WORK
M-11	FIRST FLOOR PLAN -AREA B -DUCTWORK -NEW WORK
M-12	ENLARGED PLANS -DUCTWORK -NEW WORK
M-13	ENLARGED PLANS -DUCTWORK -NEW WORK
M-14	MECHANICAL SECTIONS -DUCTWORK
M-15	FIRST FLOOR PLAN -AREA A -MECHANICAL PIPING -NEW WORK
M-16	FIRST FLOOR PLAN -AREA B -MECHANICAL PIPING -NEW WORK

INDEX OF DRAWINGS

000150 - 1

M-17	ROOF PLAN -AREA A -MECHANICAL -NEW WORK
M-18	MECHANICAL ISOMETRIC VIEWS
M-19	MECHANICAL DETAILS
M-20	MECHANICAL DETAILS
M-21	AUTOMATIC TEMPERATURE CONTROLS
M-22	AUTOMATIC TEMPERATURE CONTROLS
M-23	MECHANICAL SCHEDULES

ELECTRICAL

E-1	ELECTRICAL COVER SHEET
E-2	ELECTRICAL COVER SHEET
E-3	FIRST FLOOR PLAN -AREA A -LIGHTING -DEMOLITION
E-4	FIRST FLOOR PLAN -AREA B -LIGHTING -DEMOLITION
E-5	FIRST FLOOR PLAN -AREA A -POWER -DEMOLITION
E-6	FIRST FLOOR PLAN -AREA B -POWER -DEMOLITION
E-7	FIRST FLOOR PLAN -ENLARGED POWER -DEMOLITION
E-8	FIRST FLOOR PLAN -AREA A -LIGHTING -NEW WORK
E-9	FIRST FLOOR PLAN -AREA B -LIGHTING -NEW WORK
E-10	FIRST FLOOR PLAN -AREA A -POWER -NEW WORK
E-11	FIRST FLOOR PLAN -AREA B -POWER -NEW WORK
E-12	ROOF PLAN -POWER -NEW WORK
E-13	ELECTRICAL ONE-LINE DIAGRAM -DEMOLITION
E-14	ELECTRICAL ONE-LINE DIAGRAM -NEW WORK
E-15	ELECTRICAL EQUIPMENT SCHEDULES
E-16	PANELBOARD SCHEDULES
E-17	PANELBOARD SCHEDULES
E-18	PANELBOARD SCHEDULES
E-19	PANELBOARD SCHEDULES
E-20	PANELBOARD SCHEDULES
E-21	PANELBOARD ELEVATIONS & SCHEDULE
E-22	PANELBOARD ELEVATIONS

PLUMBING

P-1	PLUMBING COVER SHEET
P-2	FIRST FLOOR PLAN - AREA A - PLUMBING - DEMOLITION
P-3	FIRST FLOOR PLAN - AREA A - PLUMBING - NEW WORK
P-4	FIRST FLOOR PLAN - AREA B - PLUMBING - NEW WORK

FIRE ALARM

FA-1	FIRE ALARM COVER SHEET
FA-2	FIRST FLOOR PLAN – AREA A - FIRE ALARM – NEW WORK
FA-3	FIRST FLOOR PLAN – AREA B - FIRE ALARM – NEW WORK

END OF SECTION 000150

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Project information.
- 2. Work covered by Contract Documents.
- 3. Contractor's use of site and premises.
- 4. Coordination with occupants.
- 5. Work restrictions.
- 6. Specification and Drawing conventions.

- B. Related Requirements:

- 1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.
- B. All specifications references to "Architect" and "Engineer" and "Design Engineer" shall be interpreted as being equivalent.

1.4 PROJECT INFORMATION

- A. Project Identification: North Point Library HVAC Renovation

- 1. Project Location: 1716 Merritt Blvd, Dundalk, MD 21222.

- B. Owner: Baltimore County Property Management

- 1. Owner's Representative: Mebt Bekele
 - a. Address: 12200 A Long Green Pike, Glen Arm, MD 21057
 - b. Office: 410-887-3283
 - c. Cell: 443-750-0971
 - d. Email: mbekele@baltimorecountymd.gov

C. Architect: Henry Adams, LLC

1. Architect's Representative: Peter Puszczy, Senior Mechanical Engineer and David Vaeth, Mechanical Engineer
 - a. Address: 600 Baltimore Avenue, Suite 400, Towson, MD 21204
 - b. Office: 410-296-6500
 - c. Email: Puszczy@henryadams.com and Vaeth@henryadams.com

1.5 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:

1. Removal of chiller, boilers, associated pumps, and Air Handling Units (AHUs)
2. Removal of HVAC circuits back to electrical panels.
3. Replacement of electrical panels and transformers.
4. Removal of ductwork and hydronic piping as required to allow space for new systems.
5. Removal of finned-tube radiators.
6. Replacement of Fire Alarm system.
7. Replacement of original electrical panels and transformers.
8. New electrical circuits for new equipment.
9. New convenience receptacles for rooftop equipment.
10. Adding heat recovery type VRF system with Fan Coil Units (FCUs) above the ceiling throughout the building (VRF will be a Mitsubishi/Trane system).
11. Adding VRF Condensing Units (CUs) located outdoors on the building roof.
12. New air source heat pump DOAS units on the roof of the facility.
13. New console type FCUs at old finned-tube radiator locations.
14. New VRF system controls.
15. Replacement of existing Building Automation System (BAS).
16. Removal of ceilings affected by the scope of work.
17. New ceilings in areas affected by the scope of work.
18. Removal and reinstallation of existing fluorescent lights in areas affected by the scope of work.
19. New bulkheads in areas where required for the scope of work.
20. New roof and wall penetrations required for the scope of work.
21. Replace direction of door swing from the Computer Lab.
22. New partition with door assembly to reduce dead end in office/storage area.
23. Adding supplemental steel required to support rooftop equipment.
24. Adding local strengthening of existing roof joists required for new rooftop equipment.
25. Screening of rooftop equipment.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.6 CONTRACTOR'S USE OF SITE AND PREMISES

A. Restricted Use of Site: Contractor shall have limited use of Project site for construction operations. Contractor to verify limits of use with contract documents prior to project mobilization.

- B. Limits on Use of Site: Limit use of Project site to areas identified by the County prior to project mobilization. Do not disturb portions of Project site beyond areas authorized by the County.
 - 1. Driveways, Walkways and Entrances: Keep driveways , loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.7 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy Project site and **existing** building during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 - 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.

1.8 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Shall be coordinated with the Baltimore County Public Library (BCPL) prior to project mobilization. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.
 - 1. Weekend Hours: Shall be coordinated with the BCPL prior to project mobilization..
 - 2. Early Morning Hours: Shall be coordinated with the BCPL prior to project mobilization..
 - 3. Hours for Utility Shutdowns: Shall be coordinated with the BCPL prior to project mobilization..
 - 4. Hours for Core Drilling: Shall be coordinated with the BCPL prior to project mobilization.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:

1. Notify Owner not less than three days in advance of proposed utility interruptions.
 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances on Owner's property is not permitted.
- E. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Substitution Requests: Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use form acceptable to Architect.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size,

- durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - i. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - j. Cost information, including a proposal of change, if any, in the Contract Sum.
 - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

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

1.6 PROCEDURES

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

1.7 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.
1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Contractor's construction schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.
 - j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on amended AIA Document G710.

1.4 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect or Owner will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and

- finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- e. Quotation Form: Use forms acceptable to Architect.
- B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Owner.
1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 4. Include costs of labor and supervision directly attributable to the change.
 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
 7. Proposal Request Form: Use form acceptable to Architect.

1.5 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Change Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on amended **AIA Document G701**.

1.6 CONSTRUCTION CHANGE DIRECTIVE

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
 - 1. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
 - 2. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.3 DEFINITIONS

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

1.4 SCHEDULE OF VALUES

- A. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Owner's name.
 - c. Owner's Project number.
 - d. Name of Architect.
 - e. Architect's Project number.
 - f. Contractor's name and address.
 - g. Date of submittal.
 - 2. Arrange schedule of values consistent with format of **AIA Document G703**
 - 3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

4. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site.
5. Overhead Costs, Proportional Distribution: Include total cost and proportionate share of general overhead and profit for each line item.
6. Temporary Facilities: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
7. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
8. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.5 APPLICATIONS FOR PAYMENT

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

2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- F. Transmittal: Submit **three** signed and notarized original copies of each Application for Payment to **Architect** by a method ensuring receipt **within 24 hours**. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- G. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Contractor's construction schedule (preliminary if not final).
 4. Products list (preliminary if not final).
 5. Sustainable design action plans, including preliminary project materials cost data.
 6. Schedule of unit prices.
 7. Submittal schedule (preliminary if not final).
 8. List of Contractor's staff assignments.
 9. List of Contractor's principal consultants.
 10. Copies of building permits.
 11. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 12. Initial progress report.
 13. Report of preconstruction conference.
- H. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - a. Complete administrative actions, submittals, and Work preceding this application, as described in Section 017700 "Closeout Procedures."
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- I. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.

2. Certification of completion of final punch list items.
3. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
4. Updated final statement, accounting for final changes to the Contract Sum.
5. AIA Document G706.
6. AIA Document G706A.
7. AIA Document G707.
8. Evidence that claims have been settled.
9. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
10. Final liquidated damages settlement statement.
11. Proof that taxes, fees, and similar obligations are paid.
12. Waivers and releases.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. RFIs.
 - 4. Digital project management procedures.
 - 5. Project meetings.
- B. Related Requirements:
 - 1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone

numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in each built facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

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

1.6 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
 1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
 2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.

- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Owner name.
 3. Owner's Project number.
 4. Name of Architect.
 5. Architect's Project number.
 6. Date.
 7. Name of Contractor.
 8. RFI number, numbered sequentially.
 9. RFI subject.
 10. Specification Section number and title and related paragraphs, as appropriate.
 11. Drawing number and detail references, as appropriate.
 12. Field dimensions and conditions, as appropriate.
 13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 14. Contractor's signature.
 15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to Architect.
1. Attachments shall be electronic files in PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 5 days of receipt of the RFI response.

- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following: . Include the following:
1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number, including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
 8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within three days if Contractor disagrees with response.

1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Architect's Digital Data Files: Digital data files of Architect's CAD drawings will be provided by Architect for Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
 2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Digital Drawing Software Program: Contract Drawings are available in AutpCAD format.
- B. PDF Document Preparation: Where PDFs are required to be submitted to Architect, prepare as follows:
1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.8 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times a minimum of seven days prior to meeting.
 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.

- B. Preconstruction Conference: Owners Representative (Project Manger) shall schedule and conduct a preconstruction conference before starting construction, at a predetermined time convenient to all parties , but no later than 15 days after execution of the Agreement.
1. Attendees: Authorized representatives of Owner Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Responsibilities and personnel assignments.
 - b. Tentative construction schedule.
 - c. Phasing.
 - d. Critical work sequencing and long lead items.
 - e. Designation of key personnel and their duties.
 - f. Lines of communications.
 - g. Use of web-based Project software.
 - h. Procedures for processing field decisions and Change Orders.
 - i. Procedures for RFIs.
 - j. Procedures for testing and inspecting.
 - k. Procedures for processing Applications for Payment.
 - l. Distribution of the Contract Documents.
 - m. Submittal procedures.
 - n. Preparation of Record Documents.
 - o. Use of the premises.
 - p. Work restrictions.
 - q. Working hours.
 - r. Owner's occupancy requirements.
 - s. Responsibility for temporary facilities and controls.
 - t. Procedures for moisture and mold control.
 - u. Procedures for disruptions and shutdowns.
 - v. Construction waste management and recycling.
 - w. Parking availability.
 - x. Office, work, and storage areas.
 - y. Equipment deliveries and priorities.
 - z. First aid.
 - aa. Security.
 - bb. Progress cleaning.
 3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
- C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other Sections and when required for coordination with other construction.
1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Owner and Architect of scheduled meeting dates.
 2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
 - a. Contract Documents.
 - b. Options.

- c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
- 3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
 - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
- 1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 - 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of Record Documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Procedures for completing and archiving web-based Project software site data files.
 - d. Submittal of written warranties.
 - e. Requirements for preparing operations and maintenance data.
 - f. Requirements for delivery of material samples, attic stock, and spare parts.
 - g. Requirements for demonstration and training.
 - h. Preparation of Contractor's punch list.

- i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - j. Submittal procedures.
 - k. Owner's partial occupancy requirements.
 - l. Installation of Owner's furniture, fixtures, and equipment.
 - m. Responsibility for removing temporary facilities and controls.
 - 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.
- E. Progress Meetings: Conduct progress meetings at biweekly intervals. Coordinate with County for any change to frequency of meetings.
- 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.
 - 5) Off-site fabrication.
 - 6) Access.
 - 7) Site use.
 - 8) Temporary facilities and controls.
 - 9) Progress cleaning.
 - 10) Quality and work standards.
 - 11) Status of correction of deficient items.
 - 12) Field observations.
 - 13) Status of RFIs.
 - 14) Status of Proposal Requests.
 - 15) Pending changes.
 - 16) Status of Change Orders.
 - 17) Pending claims and disputes.
 - 18) Documentation of information for payment requests.
 - 4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

- a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine the critical path of Project and when activities can be performed.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Event: The starting or ending point of an activity.

- F. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file.
 - 2. PDF file.
- B. Startup construction schedule.
 - 1. Submittal of cost-loaded startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.
- D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
 - 3. Total Float Report: List of activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.
- E. Construction Schedule Updating Reports: Submit with Applications for Payment.
- F. Site Condition Reports: Submit at time of discovery of differing conditions.
- G. Unusual Event Reports: Submit at time of unusual event.

1.5 COORDINATION

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

1.6 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
 - 1. Use Microsoft Project for current Windows operating system.
- B. Time Frame: Extend schedule from date established for the Notice of Award to date of Final Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
 - 2. Temporary Facilities: Indicate start and completion dates for the following as applicable:
 - a. Securing of approvals and permits required for performance of the Work.
 - b. Temporary facilities.
 - c. Owner interfaces and furnishing of items.
 - d. Regulatory agency approvals.
 - e. Punch list.
 - 3. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - a. Generator.
 - b. Automatic Transfer Switches.
 - 4. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 - 5. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 - 6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 - 7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and Final Completion.

- D. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and the Contract Time.
- E. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate Final Completion percentage for each activity.
- F. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- G. Distribution: Distribute copies of approved schedule to Architect Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.7 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of date established for the Notice of Award.
1. Base schedule on the startup construction schedule and additional information received since the start of Project.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.
1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

1.8 REPORTS

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

NORTH POINT LIBRARY HVAC
Contract Number: 24146PO0
Job Order Number: 10000216

October 15, 2024
Final Construction Documents Submission

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Final Completion construction photographs.
- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 2. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Submit photos electronically. Include copy of key plan indicating each photograph's location and direction. Coordinate with County for submission requirements of digital media.
 - 2. Identification: Provide the following information with each image description **in file metadata tag** :
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of location, vantage point, and direction.
 - g. Unique sequential identifier keyed to accompanying key plan.

1.3 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels. Use flash in low light levels or backlit conditions.
- B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

- C. File Names: Name media files with date and sequential numbering suffix.

1.4 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs with maximum depth of field and in focus.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Owner.
 - 1. Flag excavation areas and construction limits before taking construction photographs.
 - 2. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- C. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:
 - 1. Underground utilities.
- D. Final Completion Construction Photographs: Take photographs after date of Substantial Completion for submission as Project Record Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:

1. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
3. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
4. Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and Final Completion construction photographs.
5. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
6. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
7. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
8. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
9. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

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

1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include

additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
3. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Architect.
4. Name of Contractor.
5. Name of firm or entity that prepared submittal.
6. Names of subcontractor, manufacturer, and supplier.
7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
8. Category and type of submittal.
9. Submittal purpose and description.
10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

B. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

C. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1. Email: Prepare submittals as PDF package and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
 - a. Architect will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 - 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 - 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 - 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data with Shop Drawings.
- B. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- C. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- D. Certificates:
1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
 5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.

6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.

E. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.7 CONTRACTOR'S REVIEW

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

1.8 ARCHITECT'S REVIEW

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

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

1.4 DELEGATED DESIGN SERVICES

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

1.5 CONFLICTING REQUIREMENTS

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

with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- C. Reports: Prepare and submit certified written reports and documents as specified.
- D. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.7 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement of whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement of whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.8 QUALITY ASSURANCE

- A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.
- F. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

- G. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- H. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1.9 QUALITY CONTROL

- A. **Contractor Responsibilities:** Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 2. Engage a qualified testing agency to perform quality-control services.
 - 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 - 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 - 5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 - 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- C. **Testing Agency Responsibilities:** Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 - 3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
 - 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - 6. Do not perform duties of Contractor.
- D. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

- E. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- F. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

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

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms, including "requested," "authorized," "selected," "required," and "permitted," have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms, including "shown," "noted," "scheduled," and "specified," have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
 - 1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Industry Organizations, List: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Abbreviations and acronyms not included in this list are to mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States." The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. AABC - Associated Air Balance Council; www.aabc.com.
 2. AAMA - American Architectural Manufacturers Association; (see FGIA).
 3. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
 4. ACI - American Concrete Institute; www.concrete.org.
 5. ACP - American Clean Power; (Formerly: American Wind Energy Association); www.cleanpower.org.
 6. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
 7. AIA - American Institute of Architects (The); www.aia.org.
 8. AISI - American Iron and Steel Institute; www.steel.org.
 9. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
 10. ANSI - American National Standards Institute; www.ansi.org.
 11. ASCE - American Society of Civil Engineers; www.asce.org.
 12. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (see ASCE).
 13. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
 14. ASME - ASME International; American Society of Mechanical Engineers (The); www.asme.org.
 15. ASTM - ASTM International; www.astm.org.
 16. AWPA - American Wood Protection Association; www.awpa.com.
 17. AWS - American Welding Society; www.aws.org.
 18. BICSI - BICSI, Inc.; www.bicsi.org.
 19. CDA - Copper Development Association Inc.; www.copper.org.
 20. CEA - Canadian Electricity Association; www.electricity.ca.
 21. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
 22. .
 23. DHI - Door and Hardware Institute; www.dhi.org.
 24. FM Approvals - FM Approvals LLC; www.fmaprovals.com.
 25. FM Global - FM Global; www.fmglobal.com.
 26. ICC - International Code Council; www.iccsafe.org.
 27. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
 28. IEC - International Electrotechnical Commission; www.iec.ch.

29. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
30. IES - Illuminating Engineering Society; www.ies.org.
31. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
32. .
33. ISO - International Organization for Standardization; www.iso.org.
34. MCA - Metal Construction Association; www.metalconstruction.org.
35. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
36. MPI - Master Painters Institute; www.paintinfo.com.
37. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.; www.msshq.org.
38. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
39. NACE - NACE International; (National Association of Corrosion Engineers International); (see AMPP).
40. NADCA - National Air Duct Cleaners Association; www.nadca.com.
41. NAIMA - North American Insulation Manufacturers Association; www.insulationinstitute.org.
42. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
43. NEBB - National Environmental Balancing Bureau; www.nebb.org.
44. NEMA - National Electrical Manufacturers Association; www.nema.org.
45. NETA - InterNational Electrical Testing Association; www.netaworld.org.
46. NFPA - National Fire Protection Association; www.nfpa.org.
47. NFPA - NFPA International; (see NFPA).
48. .
49. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
50. NRCA - National Roofing Contractors Association; www.nrca.net.
51. NSI - Natural Stone Institute; www.naturalstoneinstitute.org.
52. SDI - Steel Deck Institute; www.sdi.org.
53. SDI - Steel Door Institute; www.steeldoor.org.
54. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (see ASCE).
55. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
56. SPRI - Single Ply Roofing Industry; www.spri.org.
57. SSPC - SSPC: The Society for Protective Coatings; (see AMPP).
58. TIA - Telecommunications Industry Association (The); www.tiaonline.org.
59. TMS - The Masonry Society; www.masonrysociety.org.
60. UL - Underwriters Laboratories Inc.; www.ul.org.

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

1. ICC - International Code Council; www.iccsafe.org.

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

1. DOE - U.S. Department of Energy; www.energy.gov.
2. EPA - United States Environmental Protection Agency; www.epa.gov.
3. OSHA - Occupational Safety & Health Administration; www.osha.gov.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the standards and

regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from U.S. Government Publishing Office; www.govinfo.gov.
- F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
 1. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cdph.ca.gov/Programs/CCDCPHP/DEODC/EHLB/IAQ/Pages/Main-Page.aspx.
 2. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.2 USE CHARGES

- A. Installation, removal, and use charges for temporary facilities to be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Architect, testing agencies, and authorities having jurisdiction.
- B. The contractor is responsible for installing temporary electric and water and paying for same. Contractor to coordinate with the County for any exceptions for work in existing buildings.

1.3 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES

- A. Field Offices: Not required.
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.2 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

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

3.2 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary."
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services. Contractor to coordinate with the County for any exceptions for work in existing buildings.
- B. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Use of Permanent Toilets: Use of Owner's existing or new toilet facilities is not permitted.
- C. Electric Power Service:
 - 1. Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
 - 2. Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - a. Connect temporary service to Owner's existing power source, as directed by Owner. Temporary service shall provide temporary power through the existing power distribution. Contractor shall be responsible for installation and all usage costs for supplying the temporary power.

- b. Contractor to coordinate with the County for any exceptions for work in existing buildings.

3.4 SUPPORT FACILITIES INSTALLATION

A. Comply with the following:

- 1. Contractor to verify with County if any area within existing building can be utilized for temporary field offices.
- 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.

- 1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
- 2. Maintain access for fire-fighting equipment and access to fire hydrants.

C. Parking: See Section 011000 "Summary" for requirements..

D. Storage and Staging: See Section 011000 "Summary" for requirements.

E. Waste Disposal Facilities:

- 1. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- 2. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

F. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

- 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

- 1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

- 1. Comply with work restrictions specified in Section 011000 "Summary."

- C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

3.6 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
- C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor.
 - 2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for Contractor requirements related to Owner-furnished products.
 - 2. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 3. Section 014200 "References" for applicable industry standards for products specified.
 - 4. Section 017700 "Closeout Procedures" for submitting warranties.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
 - 3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.
 - 1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the

significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.

- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.
- D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:
 - 1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
 - 2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.
- E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."
- F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
 - 1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service- or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.

3. See individual identification Sections in Divisions 26 for additional equipment identification requirements.

1.5 COORDINATION

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

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Architect will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Architect, whose determination is final.
- B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

- a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."
2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."
4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.
 - a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.
5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."
6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.
 - a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
 - b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.
7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

- a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

2.2 COMPARABLE PRODUCTS

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

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Installation.
 - 3. Cutting and patching.
 - 4. Progress cleaning.
 - 5. Starting and adjusting.
 - 6. Protection of installed construction.
 - 7. Correction of the Work.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for coordination of and limits on use of Project site.
 - 2. Section 013300 "Submittal Procedures" for submitting surveys.

1.2 DEFINITIONS

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

1.3 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
 - 2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
 - 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.
- C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to existing conditions. If discrepancies are discovered, notify Architect promptly.

3.4 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 1. Make vertical work plumb, and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure satisfactory results as judged by Architect. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.
- F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.

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

3.5 CUTTING AND PATCHING

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. Temporary Support: Provide temporary support of Work to be cut.
- D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 5. Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- F. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- G. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 PROGRESS CLEANING

- A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, in accordance with regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

- D. Installed Work: Keep installed work clean. Clean installed surfaces in accordance with written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.

3.7 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

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

3.9 CORRECTION OF THE WORK

- A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.
- C. Restore permanent facilities used during construction to their specified condition.

- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Recycling nonhazardous demolition and construction waste.
 - 2. Disposing of nonhazardous demolition and construction waste.

1.3 DEFINITIONS

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

1.4 MATERIALS OWNERSHIP

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

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

3.2 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
 - a. Inspect containers and bins for contamination and remove contaminated materials if found.
 - 2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
 - 4. Store components off the ground and protect from the weather.
 - 5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.3 RECYCLING CONSTRUCTION WASTE

- A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

3.4 DISPOSAL OF WASTE

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

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final Completion procedures.
 - 3. List of incomplete items.
 - 4. Submittal of Project warranties.
 - 5. Final cleaning.
- B. Related Requirements:
 - 1. Section 012900 "Payment Procedures" for requirements for Applications for Payment for Substantial Completion and Final Completion.
 - 2. Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.
 - 3. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 4. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 5. Section 017900 "Demonstration and Training" for requirements to train Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner's signature for receipt of submittals.
 5. Submit testing records.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Complete startup and testing of systems and equipment.
 2. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 3. Terminate and remove temporary facilities from Project site, along with construction tools, and similar elements.
 4. Complete final cleaning requirements.
 5. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.7 FINAL COMPLETION PROCEDURES

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

1.8 LIST OF INCOMPLETE ITEMS

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
1. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
 2. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Page number.
 3. Submit list of incomplete items in the following format:
 - a. MS Excel Electronic File: Architect will return annotated file.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 - 1. Submit by email to Architect.
- D. Warranties in Paper Form:
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- E. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Construction Waste Disposal: Comply with waste-disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 CORRECTION OF THE WORK

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

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

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

1.4 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit by email to Architect. Enable reviewer comments on draft submittals.
 - 2. Submit two paper copies of O&M Manual to owner once approved by Architect.

- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.
 - 1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.
- D. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
 - 1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 215-by-280-mm paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 - 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 - 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
 - 4. Supplementary Text: Prepared on 215-by-280-mm white bond paper.
 - 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

- a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
- b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
 1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Construction Manager.
 7. Name and contact information for Architect.
 8. Name and contact information for Commissioning Authority.
 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

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

1.8 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.

6. Demonstration and training video recording, if available.
 - F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
 - G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
 - H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
 - I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 1. Include procedures to follow and required notifications for warranty claims.
 - J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 1. Do not use original project record documents as part of maintenance manuals.
- 1.9 PRODUCT MAINTENANCE MANUALS
- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
 - B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
 - C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
 - D. Product Information: Include the following, as applicable:
 1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record specifications.
 - 3. Record Product Data.
- B. Related Requirements:
 - 1. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set(s) of marked-up record prints in PDF electronic file format.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

1.4 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

1.5 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Note related Change Orders, Record Product Data, and Record Drawings where applicable.
- B. Format: Submit record specifications as scanned PDF electronic file(s) of marked-up paper copy of Specifications.

1.6 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.
- C. Format: Submit Record Product Data as scanned PDF electronic file(s) of marked-up paper copy of Product Data.
 - 1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

1.7 MAINTENANCE OF RECORD DOCUMENTS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

1.4 COORDINATION

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

1.5 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

- a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Systems and equipment operation manuals.
 - c. Systems and equipment maintenance manuals.
 - d. Product maintenance manuals.
 - e. Project Record Documents.
 - f. Identification systems.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments.
3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.

- b. Test and inspection procedures.
- 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

1.6 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

1.7 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- B. Scheduling: Provide instruction at mutually agreed-on times.
 - 1. Schedule training with Owner with at least 14 days' advance notice.
- C. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017900

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Commissioning procedures and protocols, common across Divisions 22, 23, and 26.
- B. Requirements specific to individual Sections are specified in the technical specifications.
- C. Pre-Functional Checklists, systems and equipment startup documentation.
- D. Functional Performance Testing.
- E. Documentation of tests, procedures, and installations.
- F. Coordination and requirements of training events.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Division 22 - Plumbing
- C. Division 23 – Heating Ventilating and Air Conditioning
- D. Division 26 – Electrical

1.3 QUALITY ASSURANCE

- A. Commissioning (Cx) is the process of ensuring that all building systems are installed and perform interactively according to the design intent and meet the Owner's operational needs; that the installation is adequately documented; and that the Building Operations staff are adequately trained to operate the facility. Commissioning helps minimize post-acceptance operational problems and establishes testing and communication protocols that advance the building systems from design to installation to full operation.
- B. The specifications dictate all requirements of the commissioning process relative to the construction contract. The Commissioning Plan outlines the commissioning process. The Contractor shall be responsible for complying with any additional duties or responsibilities contained in the Commissioning Plan that are not otherwise specified in the Contract Documents.

1.4 SCOPE

- A. Systems to be commissioned:

1. Heating, ventilating, air-conditioning and refrigeration systems (mechanical and/or passive) and associated controls.

1.5 DEFINITIONS AND ABBREVIATIONS

- A. Acceptance Phase: This is the phase of the project when the facility and its systems and equipment are inspected, tested, verified, and documented; and when most of the Functional Performance Testing and formal training occurs.
- B. Action Item: Any issue that requires a response, completion, corrective or additional work, or any other action. A list will be maintained and updated by the CxA that includes all Action Items that relate to Commissioning activities.
- C. Commissioning (Cx): The process of ensuring that all building systems perform interactively according to the design intent and meet the Owner's operational needs.
- D. Commissioning Agent (CxA): The individual (and firm) who will manage the commissioning process, develop and stipulate many of the commissioning requirements, and who ensures and validates that systems and equipment are designed, installed and tested to meet the Owner's requirements.
- E. Commissioning Plan (Cx Plan): Plan developed by the CxA to provide an overview of the commissioning process and its requirements for the Cx Team.
- F. Commissioning Team (CxT): The commissioning process participants, including the Owner's representatives, Engineer/Architect of Record, Construction Manager/General Contractor, subcontractors, equipment manufacturers' representatives and technicians, Owner's appointed building operations personnel, and the Commissioning Agent.
- G. Deficiency: An installation or condition that is not in conformance with the Construction Documents.
- H. Functional Performance Testing (FPT): The detailed and thorough testing of the building systems and their interactions with building components and other building systems.
- I. Pre-Functional Checklist (PFC): A checklist used as a guide to confirm and document proper equipment installation and checkout.
- J. Startup: Refers to the quality control process whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the manufacturer's startup checklist, energizes the device, completes the startup tests, and verifies that it is in proper working order and ready for dynamic testing.
- K. Commissioning Issues/Deficiency Log (Issues Log): A list of items tracked by the CxA that require action and resolution by various members of the commissioning team, including design related clarifications, issues identified through field observation, or testing deficiencies.

1.6 REFERENCE STANDARDS AND DOCUMENTS

- A. ASHRAE Guideline 0-2019: The Commissioning Process

- B. ASHRAE/IES Standard 202-2018: Commissioning Process for Buildings and Systems
- C. ACG Commissioning Guideline (Current Edition)
- D. BCA New Construction Building Commissioning Best Practices (Current Edition)
- E. ICC G4 – 2018 Guideline for Commissioning
- F. NEBB – Procedural Standards for Building Systems Commissioning (Current Edition)

1.7 COMMISSIONING FIRM AND AGENT QUALIFICATIONS

- A. The Commissioning Firm shall typically be retained by the Owner. In circumstances where it is permissible for the Construction Manager or General Contractor to retain the services of the Commissioning Firm, the Commissioning Firm is required to communicate directly with the Owner/Owner's Representative throughout the commissioning process. The Commissioning Firm shall be a member of the Associated Air Balance Council Commissioning Group (ACG), the Building Commissioning Association (BCA), the National Environmental Balancing Bureau (NEBB), Association of Energy Engineers (AEE), or equivalent.
- B. Commissioning Agent Certification: The lead commissioning agent shall hold one of the following credentials:
 - 1. ACG Certified Commissioning Agent (CxA)
 - 2. BCA Certified Commissioning Professional (CCP)
 - 3. ASHRAE Building Commissioning Professional Certification (BCxP)
 - 4. Association of Energy Engineers Certified Building Commissioning Professional (CBCP)
 - 5. NEBB Certified Commissioning Process Provider (CCPP)
 - 6. University of Wisconsin – Madison – Qualified Commissioning Process Provider (QCPP)

1.8 DOCUMENTATION

- A. Contractor and Subcontractors shall submit qualifications for Cx Coordinators, who may also hold additional responsibilities on the Contractor's or Subcontractors' teams.
- B. Submittals: Provide an electronic copy of all approved equipment and system submittals to the CxA.
- C. Factory Test Reports: Prior to Functional Performance Testing the Contractor shall provide any factory testing documentation or certified test reports required by the specifications.
- D. Schedule: Provide the CxA with schedule updates when issued to the construction team and incorporate commissioning activities into the project schedule.
- E. Action Item and/or Issues Log Response: Respond to Issues Log and Action Items to which CxA team members assign the Contractor responsibility.
- F. Pre-Functional Checklists: Complete pre-functional checks of equipment and systems and provide signed and completed documents to the CxA.

- G. Factory and Manufacturer's Test Reports: Prior to Functional Performance Testing, the Contractor shall provide any factory or manufacturer's testing documentation or certified test reports required by the specifications.
- H. Test and Balance Report: Prior to Functional Performance Testing the Contractor shall provide the CxA with test and balance reports for review and comment.
- I. Functional Performance Tests: Provide completed and signed FPT documentation.
- J. Training Documentation: Provide record of all training documentation. Refer to 018200 Demonstration and Training for deliverables.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

- A. The Contractor provides all tools, equipment, and instruments needed for the testing process. All testing equipment used by the Contractor in the commissioning process shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified. All equipment shall be calibrated according to the manufacturer's recommended intervals. Calibration tags shall be affixed to equipment or certificates readily available.
- B. The Contractor shall provide any special equipment, tools and instruments (only available from a vendor, and specific to a piece of equipment) that are required for testing equipment. These shall be provided to the Owner as part of the contract (for example, a handheld device that is necessary to retrieve, change, and view information from a manufacturer's proprietary controller).

PART 3 - EXECUTION RESPONSIBILITIES

3.1 RESPONSIBILITIES

- A. Contractor responsibilities include but are not limited to:
 - 1. Designate a Cx Coordinator who is authorized to direct subcontractors and make commissioning related schedule and scope of work decisions. Cx Coordinator may have other roles on the GC's project team.
 - 2. Designate a Cx Coordinator from each major subcontractor with activities related to commissioning. Engage the subcontractors to directly participate and support the commissioning process.
 - 3. Attend Cx Kick-Off Meeting.
 - 4. Attend all Cx progress meetings.
 - 5. Provide documentation listed in Section 1.8 to the CxA.
 - 6. Schedule and coordinate Cx efforts into the construction schedule.
 - 7. Submit commissioning RFIs through the project RFI protocol. Incorporate AE responses into the construction process, including as-builts.
 - 8. Respond to and address CxA comments on submittals and O&Ms, including providing revised submissions when requested to clarify or correct information.
 - 9. Perform equipment and system start-up and provide documentation to the CxA.

10. Review draft PFCs and FPTs provided by the CxA, and provide comments to the CxA.
11. Complete PFCs and provide documentation to the CxA.
12. Conduct and document the FPT procedures as directed and witnessed by the CxA.
13. Provide the necessary tools, technicians, utilities, access, lifts, ladders, etc. to support the testing.
14. Remedy deficiencies identified through the commissioning process.
15. Demonstrate the proper operation of all systems via the FPT process.
16. Respond to and proactively resolve Issues Log items tracked by the CxA.
17. Conduct and document equipment and systems training events in accordance with the specifications.
18. Participate in opposite season, full load and deferred testing as needed.
19. Give minimum two 14 days' notice to the Owner and CxA for any commissioning activity which must be witnessed by the CxA. Provide at least 7 days' notice for commissioning related testing that the CxA may witness, such as system pressure testing, TAB activities, and manufacturer's startups.

B. Architect/Engineer of Record responsibilities include but are not limited to:

1. Provide the Owner's Project Requirements (OPR).
2. Provide the project Basis of Design (BOD).
3. Review the Commissioning Plan, PFCs, and FPTs and provide input and comments.
4. Incorporate commissioning and testing requirements into the Construction Documents.
5. Clarify the design intent when requested by the CxA or other members of the Cx Team, including answering CxA generated RFIs.
6. Include the CxA directly on all RFI responses and all ASIs. For the commissioned systems, include the CxA directly on submittal review responses.
7. Attend Cx progress meetings when design issue discussion is anticipated.

C. Commissioning Agent responsibilities include but are not limited to:

1. Serve as a third-party advocate for the Owner.
2. Manage and lead the commissioning process.
3. Create and update the Commissioning Plan.
4. Review the Owner's Project Requirements (OPR) and the Basis of Design (BOD) documents.
5. Review the design documents.
6. Work with the AE to incorporate commissioning requirements into the Construction Documents.
7. Lead commissioning meetings and issue meeting minutes.
8. Review product data submittals and O&M manuals for the systems to be commissioned.
9. Create PFCs and FPTs. Offer the checklists and procedures to the team for review and input, and update the documents when necessary.
10. Backcheck select PFCs to confirm thoroughness and accuracy of Contractor and Subcontractor installation and startup.
11. Conduct periodic site visits and issue field reports.
12. Direct and witness functional testing conducted by the contractors.
13. Track systems issues discovered during the Cx process and backcheck to ensure resolution.
14. Facilitate the O&M training process.
15. Review O&M documentation for completeness.
16. Generate the Commissioning Report.
17. Conduct seasonal/full load/deferred testing, if required, and update Commissioning Report.

18. Compile contractor provided closeout documentation and commissioning process documentation into a Systems Manual for Owner.

D. CM responsibilities include:

1. Review and provide input on the Cx Plan, PFCs, and FPTs.
2. Attend commissioning meetings and participate in the commissioning process.
3. Copy the CxA on construction progress and owner's meeting minutes.
4. Provide requested information to the commissioning agent, including submittals, RFIs, PCOs, etc..
5. Resolve GC contractual matters related to the commissioning process.
6. Enforce commissioning testing, and QA/QC requirements during contractor performance of the work.
7. Work with the GC, Owner, and CxA to proactively resolve issues.
8. Inspect systems, equipment, and related components for construction acceptance (the commissioning process does not replace the construction QA/QC process).

E. Owner responsibilities include:

1. Contract an independent Commissioning Agent.
2. Determine and document the Owner's Project Requirements.
3. Provide availability of O&M staff for training purposes and time for the Maintenance Supervisor to participate in the commissioning process as appropriate.
4. Determine final acceptance of the systems based on CxA recommendations.
5. Engage staff as needed to provide input to the AE and Owner for the Owner's Project requirements and general project programming requirements.

F. Maintenance Supervisor (MS) responsibilities include:

1. Attend Cx meetings as needed.
2. Participate in the commissioning process to the extent possible to better assist in the transition of the facility from Construction and Acceptance to O&M.
3. Provide input to the OPR / BOD.
4. Provide input to the Owner, CxA, and AE regarding the desired level of training and the system documentation needs of the facility.
5. Provide access to base building systems and networks for systems related renovations.
6. Schedule technicians to attend portions of FPTs to better understand systems operations prior to turnover.
7. Actively participate and schedule crews for the O&M training process.

3.2 COMMISSIONING SEQUENCING AND SCHEDULING

A. Commissioning is categorized in the phases indicated below. Note that different systems and/or areas may be in different commissioning phases at any given time.

1. Pre-Construction Phase: All activities and coordination that take place prior to the start of construction. This includes preparation of the initial or draft Commissioning Plan, review of the Owner's Project Requirements, Basis of Design, drawings and specifications.
2. Construction Phase: This period starts with the construction phase commissioning kick-off meeting and the product data submittal process. Preliminary O&Ms are produced. Checklists and functional test procedures are developed. The systems to be commissioned

- are installed. The Construction Phase ends as the systems transition into start-up and testing.
3. Acceptance Phase: In this period systems are started, TAB is performed, and functional performance testing is conducted. Training is completed concurrently with functional testing and final O&Ms are submitted. The systems will operate in automatic mode and trends shall be programmed on the BAS and downloaded and provided to the CxA. This period ends with satisfactory completion of all functional performance tests prior to Substantial Completion or Post-Acceptance.
 4. Post-Acceptance Phase: The Post-Acceptance phase starts after all FPTs are complete and accepted by Owner, and systems are operating per the Contract Documents. The Post-Acceptance Phase runs concurrent with the warranty period. During this period the CxA submits the Preliminary Cx Report which includes outstanding items that must be completed, including action items on the Issues Log and deferred tests. The Contractor resolves any remaining Issues Log items, addresses any warranty items, and completes any remaining deferred or seasonal testing. This phase ends typically one-year after Substantial Completion but is project specific.
- B. Prior to submission of the baseline schedule, Contractor will coordinate with the CxA to specifically include the detailed tasks involved in the Cx Process. Contractor shall incorporate the commissioning tasks for EACH SYSTEM. Contractor shall submit each schedule update directly to the CxA and incorporate and respond to any CxA schedule comments.
- C. Contractor shall notify the CxA in writing at least 14 days in advance of major equipment startup, the start of testing and balancing, training sessions, and other events requested by the CxA. Contractor shall provide at least 7 days' notice for activities that the CxA may witness at its option (such as pressure testing, flushing, energization, etc.).

3.3 PRE-FUNCTIONAL CHECKLISTS AND START-UP PROCEDURES

- A. The CxA will create the Pre-Functional Checklists (PFCs) based on manufacturers' startup procedures and checklists, which shall be provided by the Contractors. The CxA will utilize the product submittals, contract documents, and other relevant information as needed to ensure that the startup phase documentation is complete. The contractors will use the PFCs as a guide to check each piece of equipment and system installation and document the results.
- B. Prepare and submit Startup Procedures. Contractor shall provide manufacturer's installation and start-up documentation, including manufacturer's standard startup checklists, forms, and protocols. Provide information early in the construction process so the CxA and the construction team have the information for preparation of the Pre-Functional Checklists.
- C. Equipment and system start-up are contractor responsibilities. The CxA will selectively witness startups. Contractor will coordinate with the CxA to confirm startup schedule. Provide factory trained/authorized technicians where required by the contract documents and stated in the applicable technical section. Generally, startup and testing shall proceed from device checkout, to component checkout, to system checkout, to interrelated system checkout.
- D. Contractor shall provide completed PFCs, startup documentation, and the Test and Balance Report (TAB Report) for the equipment to be tested to CxA prior to any associated functional performance testing. Any outstanding item shall be clearly indicated and an associated action item must be tracked to resolution. By submitting the completed documentation, the contractor is confirming that it has successfully checked out, started-up, balanced, and confirmed proper operation of the systems to be tested.

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. Functional Performance Testing demonstrates that each system is operating according to the Contract Documents. The tests will verify the full operation of every mode of operation, sequence, control point, input, output, device, meter, sensor, component, alarm, and graphic of every piece of equipment and system in every mode of operation. All portions of the sequence of operation will be tested and verified.
- B. The CxA will develop the FPTs. The Cx Team will review the draft FPTs and provide comments to the CxA. The CxA shall update the FPTs as needed.
- C. The contractors shall conduct the FPTs and provide the following:
 - 1. Manipulate systems and equipment to facilitate Functional Performance Testing.
 - 2. Provide any specialized instrumentation necessary for Functional Performance Testing.
 - 3. Manipulate the BAS and other control systems to facilitate Functional Performance Testing.
 - 4. Correct any work found not in accordance with Contract Documents.
 - 5. Provide access to the equipment and systems for review and testing, such as removing and replacing ceiling tiles, removing access panels, providing and moving ladders, lifts and scaffolding, etc.
- D. The CxA determines the pass or failure of each step of the FPT process. Items that fail must be corrected and retested at no additional cost to the Owner. Corrections of minor deficiencies may be made during the tests at the discretion of the CxA and will be documented.
- E. The CxA will record all deficiencies or non-conformance issues in the project Issues Log as follows.
 - 1. The CxA will notify the Owner, CM, Contractor and all members of the Cx Team of issues added or closed by distributing the Issues Log to the team on a regular basis.
 - 2. Items assigned shall be corrected by the responsible party and notice sent to the CxA that the item has been corrected.
 - 3. The Contractor shall provide applicable documentation and/or demonstrate the correction to the reasonable satisfaction of the CxA.
 - 4. If there is a dispute about a deficiency, regarding whether it is a deficiency, and/or who is responsible, and/or a contractual issue then the contractor shall notify the CM, Owner, and CxA to determine the outcome.
- F. Deferred Testing (or Full-Load Testing). Testing that cannot be completed during the Acceptance Phase due to seasonal or phasing issues will be conducted at a (later) time to be determined. Any items to be deferred must be approved by the Owner. Contractor is responsible for conducting seasonal and deferred testing in the same manner as the FPTs.
- G. Sampling. The CxA may incorporate an FPT sampling strategy for numerous and repetitive equipment at their discretion. This will generally apply to terminal equipment. Regardless, Contractor shall remain responsible for completing the PFCs for every single piece of equipment. Further, should a sampling group result in any failures, additional tests, or additional samples, the Contractor shall be responsible for all costs of completing FPTs on 100% of the equipment and systems.

3.5 TRAINING

- A. The Contractor conducts the training and the CxA shall verify that adequate training has been provided. Refer to Section 01 82 00 Demonstration and Training for further requirements.

END OF SECTION 019113

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Demolition and removal of selected portions of a building.
 - 2. Repair procedures for selective demolition operations.
- B. Related Sections:
 - 1. Section 015480 "Use, Handling, Storage, Transporting, Accumulation and Disposal of NIH Controlled Material" for work with hazardous materials.
- C. Definitions:
 - 1. Remove: Detach items from existing construction and legally dispose of them.
 - 2. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.
 - 3. Salvage: Same definition as Remove and Salvage.
 - 4. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
 - 5. Existing to Remain: Existing items of construction that are not to be removed.

1.2 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be salvaged, reinstalled or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at Contractor's option.

1.3 SUBMITTALS

- A. Qualification Data: List of demolition firm's completed projects with project addresses, and names and addresses of architects and owners.
- B. Proposed dust-control measures.
- C. Proposed noise-control measures.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition work, with starting and ending dates for each activity.
 - 2. Interruption of utility services.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Locations of temporary partitions and means of egress.
 - 6. Procedures to ensure uninterrupted progress of Owner's on-site operations.
 - 7. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Inventory: Items to be removed and salvaged.
- F. Photographs or Videotape: Before work begins, submit sufficiently detailed photographs or videotapes showing existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations.

- G. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.4 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Firm shall be a Specialist in demolition work of similar materials and extent to that indicated for this Project.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with NFPA 241 and ANSI A10.6.
- D. Pre-Demolition Conference: Conduct conference at Project site to comply with requirements in Division 1 section "Project Management and Coordination." Review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by demolition operations.

1.5 PROJECT CONDITIONS

- A. Owner will occupy portions of the building immediately adjacent to selective demolition area.
 - 1. Conduct selective demolition so Owner operations will not be disrupted.
 - 2. Provide the COR's with not less than 72 hours notice prior to activities that will affect Owner operations.
- B. Maintain access to existing walkways, corridors and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.
- C. The Owner will remove the existing items so indicated on the Drawings.
- D. The Contractor shall remove and salvage the existing items so indicated on the Drawings.
- E. The Contractor shall remove and reinstall the existing items so indicated on the Drawings.
- F. Hazardous Materials: Unless otherwise noted on the drawings, it is not expected that hazardous materials will be encountered in the Work. If any material suspected of containing hazardous materials is encountered, do not disturb the material.
 - 1. Immediately notify the COR's.
 - 2. Hazardous materials will be removed by the Owner.
- G. Refer to Specification Section 01 5480 for further information on use, handling, storage, transporting, accumulation and disposal of NIH controlled material.
- H. On-site storage or sale of removed items or materials will not be permitted.
- I. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
- J. Fire Protection: Maintain fire-protection services during selective demolition operations.

1.6 WARRANTIES

- A. Existing Special Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials that do not void existing warranties.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

- A. Where available and appropriate for use, provide repair materials that are identical to existing materials.
- B. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
- C. Use materials whose installed performance equals or surpasses that of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities to be removed have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled, and items to be removed and salvaged.
- D. When encountering unanticipated mechanical, electrical or structural elements that conflict with the intended function or design, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the COR's.
- E. Survey the condition of the building to determine whether removing any element might result in a structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.
- F. Perform surveys as the selective demolition progresses to detect hazards resulting from the activities.

3.2 UTILITY SERVICES

- A. Existing Utilities: Maintain services indicated to remain and protect them against damage during selective demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by authorities having jurisdiction.
 - 1. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.
- C. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated utilities when requested by Contractor.
 - 2. Arrange to shut off indicated utilities with utility companies.
 - 3. Where utility services are required to be removed, relocated or abandoned, provide

bypass connections to maintain continuity of service to other parts of the building before proceeding with selective demolition.

4. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal the remaining portion of pipe or conduit after bypassing.
5. Do not start selective demolition work until utility disconnection and sealing have been completed and verified.

3.3 PREPARATION

- A. Dangerous Materials: Drain, purge or otherwise remove, collect and dispose of chemicals, gases, explosives, acids, flammables or other dangerous materials before proceeding with selective demolition operations.
- B. Pest Control: Employ a certified, licensed exterminator to treat building and to control rodents and vermin before and during selective demolition operations.
- C. Temporary Site Control: Remove debris and conduct demolition operations in a manner to ensure minimum interference with roads, streets, walks, walkways, corridors, and other adjacent occupied or used facilities.
 1. Do not close or obstruct streets, walks, walkways, corridors, or other adjacent occupied or used facilities without permission from the COR's and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- D. Temporary Facilities: Conduct demolition operations in a manner to prevent injury to people and damage to adjacent building and facilities to remain. Provide for safe passage of people around selective demolition area.
 1. Protect walls, ceilings, floors and other existing finish work that are to remain and are exposed during selective demolition operations.
 2. Cover and protect furniture, furnishings and equipment that have not been removed.
- E. Temporary Enclosures: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.

3.4 POLLUTION CONTROLS

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

3.5 SELECTIVE DEMOLITION

- A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete selective demolition within limitations of

governing regulations and as follows:

1. Proceed with selective demolition systematically. Conduct work in an order that avoids transporting removed items and debris through areas with completed selective demolition work, and that allows for removal of items before supports for those items are removed in another area.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage adjoining construction to remain. Use hand or small power tools designed for sawing or grinding, not for hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations, and maintain adequate ventilation when using cutting torches.
 5. Remove decayed, vermin-infested and other dangerous or unsuitable materials, and promptly dispose of these materials off-site.
 6. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors or framing.
 7. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.
- B. Existing Facilities: Comply with building manager's regulations for using and protecting elevators, stairs, walkways, loading docks, building entries and other building facilities during selective demolition operations.
- C. Repair and Storage of Salvaged Items and Items to be Reinstalled:
1. Repair: Clean and repair the materials and equipment to functional condition adequate for intended reuse. Paint damaged or deteriorated painted surfaces of equipment to match new equipment.
 2. Storage: Store the materials and equipment in a secure area until final disposal.
- D. Disposal of Salvaged Items and Items to be Reinstalled:
1. Reinstallation: Where items are indicated to be removed and reinstalled, install the materials and equipment in locations indicated. Comply with installation requirements for new materials and equipment.
 2. Delivery to Owner: Where items are indicated to be removed and salvaged, transport the materials and equipment to the area on-site designated by the Contracting Officer's Representative or indicated on the Drawings.
- E. Protection of Salvaged Items: Pack or crate salvaged materials and equipment after removal. Identify contents of containers. Protect items from damage during transport and storage.
- F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the COR's, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.
- G. Concrete and Masonry: Demolish concrete and masonry in small sections. At junctures with construction to remain, cut concrete and masonry using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- H. Resilient Floor Coverings: Remove floor coverings and adhesive, and prepare substrate for new floor covering, according to recommendations of the Resilient Floor Covering Institute.

- I. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

3.6 PATCHING AND REPAIRS

- A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.
- B. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
 - 1. Completely fill holes and depressions in existing masonry walls to remain with an approved masonry patching material, applied according to the manufacturer's written recommendations.
- C. Finishes: Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.
- D. Floor and Wall Surfaces: Patch and repair floor and wall surfaces in each space where demolished walls or partitions result in extending one finished area into another. Provide a flush and even surface of uniform color and appearance.
 - 1. Closely match texture and finish of existing adjacent surface.
 - 2. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.
 - 3. Where patching smooth painted surfaces, extend final paint coat over entire unbroken surface containing the patch after the patched surface has received primer and other specified undercoats.
 - 4. Remove existing floor and wall coverings and replace with new materials, if necessary to achieve uniform color and appearance.
 - 5. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
- E. Ceilings: Patch, repair or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
- B. Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner property and legally dispose of them.

END OF SECTION 024119

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Concrete masonry units (CMUs).
 - 2. Face brick.
 - 3. Mortar and grout.
 - 4. Reinforcing steel.
 - 5. Masonry joint reinforcement.
 - 6. Ties and anchors.
 - 7. Miscellaneous masonry accessories.
- B. Related Sections include the following:
 - 1. Division 07 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.
- C. Products furnished, but not installed, under this Section include the following:
 - 1. Anchor sections of adjustable masonry anchors for connecting to structural frame, installed under Division 05 Section "Structural Steel Framing."
- D. Products installed, but not furnished, under this Section include the following:
 - 1. Precast architectural concrete units furnished under Division 03 Section "Plant-Precast Architectural Concrete."
 - 2. Steel lintels and shelf angles for unit masonry, furnished under Division 05 Section "Metal Fabrications."

1.3 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Concrete masonry units.
 - 2. Face brick, Show sizes, and profiles of special shapes.

3. Special brick shapes.
 4. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 5. Accessories embedded in masonry.
 6. Calcium silicate masonry units and trim: Show sizes, and profiles of each unit required
- B. Shop Drawings: For the following:
1. Masonry Units:
 - 2.
- C. Samples: For each type and color of the following:
1. Face brick, in the form of straps of five or more bricks.
 2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 3. Calcium silicate masonry units and trim.
 4. Accessories embedded in masonry.
- D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include material test report for efflorescence according to ASTM C 67.
 2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 4. Grout mixes. Include description of type and proportions of ingredients.
 5. Joint reinforcement.
 6. Anchors, ties, and metal accessories.
- F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
 2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.
 - 2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe and hold cover in place.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide shapes indicated and as follows:
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide bullnose units for outside corners, unless otherwise indicated.
- B. Integral Water Repellent: Provide units made with integral water repellent.
 - 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.
 - a. Products:
 - 1) Addiment Incorporated; Block Plus W-10.

- 2) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block.
- 3) Master Builders, Inc.; Rheopel.

C. Concrete Masonry Units: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa).
2. Weight Classification: Normal weight, unless otherwise indicated.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

2.4 BRICK

A. General: Provide shapes indicated and as follows:

1. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, and lintels.
2. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
3. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Face Brick: ASTM C 216, Grade SW, Type FBS.

1. Application: Use where brick is exposed, unless otherwise indicated.
2. Basis of Design: TBD. Submit a minimum of 3 options for Architect to select from. Match existing brick.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.

B. Masonry Cement: ASTM C 91.

1. Products:

- a. Capital Materials Corporation; Flamingo Color Masonry Cement.
- b. Essroc, Italcementi Group; Brixment.
- c. Lafarge North America Inc.; Lafarge Masonry Cement.
- d. Lehigh Cement Company; Lehigh Masonry Cement.

C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products:

- a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
- b. Davis Colors; True Tone Mortar Colors.
- c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.

- D. Colored Cement Product: Packaged blend made from portland cement and lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 2. Pigments shall not exceed 10 percent of portland cement by weight.
 3. Pigments shall not exceed 5 percent of masonry cement by weight.
 4. Products:
 - a. Colored Portland Cement-Lime Mix:
 - 1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
 - 2) Lafarge North America Inc.; Eaglebond.
 - 3) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
 - b. Colored Masonry Cement:
 - 1) Capital Materials Corporation; Flamingo Color Masonry Cement.
 - 2) Essroc, Italcementi Group; Brixment-in-Color.
 - 3) Lafarge North America Inc.; Magnolia Masonry Cement.
 - 4) Lehigh Cement Company; Lehigh Custom Color Masonry Cement.
- E. Aggregate for Mortar: ASTM C 144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. White-Mortar Aggregates: Natural white sand or crushed white stone.
 3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- F. Aggregate for Grout: ASTM C 404.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. Products:
 - a. Addiment Incorporated; Mortar Kick.
 - b. Euclid Chemical Company (The); Accelguard 80.
 - c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
 - d. Sonneborn, Div. of ChemRex; Trimix-NCA.
- H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
1. Products:
 - a. Addiment Incorporated; Mortar Tite.
 - b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
 - c. Master Builders, Inc.; Rheomix Rheopel.

- I. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615, Grade 60
- B. Masonry Joint Reinforcement, General: ASTM A 951.
1. Exterior Walls: Hot-dip galvanized, carbon steel.
 2. Wire Size for Side Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
 3. Wire Size for Cross Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
 4. Wire Size for Veneer Ties: W1.7 or 0.148-inch (3.8-mm) diameter.
 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
 6. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
- D. Masonry Joint Reinforcement for Multiwythe Masonry:
1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches (100 mm) in width, plus 1 side rod at each wythe of masonry 4 inches (100 mm) or less in width.
 2. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.
 3. Size: Standard length 10 to 20 feet; side rods spaced approximately 2 inches less than width of partition or wall in which placed. Provide prefabricated tee and corner units.
 4. Finish: Exterior walls; ASTM A153, Class B-2, (minimum 1.5 OZ/SQ FT zinc coating) hot-dip galvanized.
 5. Acceptable Product: Dur-O-Ladur-Eye Truss, Dur-O-Wal or approved equal.
- E. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized, carbon-steel continuous wire.

2.7 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with eight subparagraphs below, unless otherwise indicated.
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
 3. Stainless Steel bars: ASTM A 276 or ASTM a 666, Type 304.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
 2. Where wythes do not align, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
 3. Wire: Fabricate from 3/16-inch- (4.8-mm-) diameter, hot-dip galvanized steel.
- D. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.4-mm-) diameter, hot-dip galvanized steel.
 2. Tie Section for Steel Frame]: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized steel.
- E. Stone Anchors: Fabricate dowels, cramps, and other stone anchors from stainless steel.
- F. Adjustable Masonry-Veneer Anchors
1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to metal studs, and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
 2. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:
 3. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.
 - a. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical leg of connector section.
 - b. Connector Section: Rib-stiffened, sheet metal bent plate with down-turned leg designed to fit in anchor section slot and with integral tabs designed to engage continuous wire. Size connector to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face.
 - c. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (75 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section. Size wire tie to extend at least 1-1/2 inches (38 mm) into veneer but with at least 5/8-inch (16-mm) cover on outside face.
 - d. Connector Section: Sheet metal clip welded to wire tie with integral tabs designed to engage continuous wire.
 - e. Anchor Section: Gasketed sheet metal plate, 1-1/4 inches (32 mm) wide by 6 inches (150 mm) long, with screw holes top and bottom; top and bottom ends bent to form pronged legs to bridge insulation or sheathing and contact studs; and raised rib-stiffened strap, 5/8 inch (16 mm) wide by 6 inches (150 mm) long, stamped into center to provide a slot between strap and plate for inserting wire tie. Provide anchor

- manufacturer's standard, self-adhering, modified bituminous gaskets manufactured to fit behind anchor plate and extend beyond pronged legs.
- f. Connector Section: Triangular wire tie and rigid PVC extrusion with snap-in grooves for inserting continuous wire. Size wire tie to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face.
 - g. Fabricate sheet metal anchor sections and other sheet metal parts from 0.067-inch- (1.7-mm-) thick, steel sheet, galvanized after fabrication.
 - h. Fabricate wire connector sections from 0.188-inch- (4.8-mm-) diameter, hot-dip galvanized, carbon-steel wire.
 - i. Products:
 - 1) Dayton Superior Corporation, Dur-O-Wall Division; D/A 213S.
 - 2) Hohmann & Barnard, Inc.; DW-10-X-Seismiclip.
 - 3) Wire-Bond; RJ-711 with Wire-Bond clip.
4. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than 3 exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
- a. Products:
 - 1) ITW Buildex; Teks Maxiseal with Climaseal finish.
 - 2) Textron Inc., Textron Fastening Systems; Elco Drill-Flex with Stalgard finish.
5. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 (4.8-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads.
- a. Products:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; Stainless Steel SX Fastener.
 - 2) ITW Buildex; Scots long life Teks.

2.8 MISCELLANEOUS ANCHORS

- A. Postinstalled Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group 1 or 4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

2.9 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, complying with Division 07 Section "Sheet Metal Flashing and Trim" and as follows:
 - 1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.4 mm) thick.

2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond.
 - a. Products:
 - 1) Cheney Flashing Company; Cheney Flashing (Dovetail) or Cheney 3-Way Flashing (Sawtooth).
 - 2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thruwall Flashing.
4. Fabricate through-wall flashing with drip edge, unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch (3.6-mm) steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
 1. Products:
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
 - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
 - c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
 - d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.11 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.
- B. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 1. Manufacturers:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

2.12 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.

2. Limit cementitious materials in mortar to portland cement, and lime.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
1. For masonry below grade or in contact with earth, use Type S.
 2. For reinforced masonry, use Type S.
 3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments shall not exceed 10 percent of portland cement by weight.
 2. Pigments shall not exceed 5 percent of masonry cement by weight.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
- F. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 2. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
- G. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

2.13 SOURCE QUALITY CONTROL

- A. Contractor will engage a qualified independent testing agency to perform source quality-control testing indicated below.
1. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
 2. Copies of all test reports are to be submitted to the inspector and the Architect within 48 hours.
- B. Clay Masonry Unit Test: For each type of unit furnished, per ASTM C 67.
- C. Concrete Masonry Unit Test: For each type of unit furnished, per ASTM C 140.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

- A. Thickness: Build composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
 - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
 - 2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
 - 3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
 - 4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm). Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).

5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- G. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow concrete masonry units as follows:
 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Set stone trim and cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 2. Wet joint surfaces thoroughly before applying mortar.
- D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.5 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together using one of the following methods:
1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. (0.25 sq. m) of wall area spaced not to exceed 24 inches (610 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
 - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties].
- B. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
- C. Corners: Provide interlocking masonry unit bond in each wythe and course at corners, unless otherwise indicated.
 1. Provide continuity with masonry joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.
- D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
 1. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.

3.6 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
1. Provide an open space not less than 1/2 inch (13 mm) in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.7 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing with seismic masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten screw-attached and seismic anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 - 2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
 - 3. Embed connector sections and continuous wire in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
 - 4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 5. Space anchors as indicated, but not more than 18 inches (458 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 8 inches (203 mm), around perimeter.

3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form expansion joints in brick made from clay or shale as follows:
 - 1. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch (10 mm) for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."

3.9 LINTELS

- A. Install steel lintels where indicated.

3.10 FIELD QUALITY CONTROL

- A. Inspectors: Contractor will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
 - 1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
- B. Testing Agency: Contractor will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
 - 1. Copies of all test reports are to be given to BCPSS project manager and Architect within 48 hours of completion of test.
 - 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. (465 sq. m) of wall area or portion thereof.

- D. Mortar Test (Property Specification): For each mix provided, per ASTM C 780.
- E. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.
- F. Prism Test: For each type of construction provided, per ASTM C 1314 7 days and at 28 days.

3.11 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20 or with a proprietary acidic cleaner applied according to manufacturer's written instructions
 - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
 - 7. Clean stone trim to comply with stone supplier's written instructions.
 - 8. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.12 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 051200 - STRUCTURAL STEEL

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 includes the following:
 - 1. Structural steel and related connections.
 - 2. Anchor bolts, bearing plates, and steel lintels and shelf angles.
 - 3. Grout for base plates.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
- C. Welding certificates.
- D. Qualification Data: For Installer and fabricator.
- E. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Shop primers.
 - 4. Nonshrink grout.
- F. Field quality-control test and inspection reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, qualified according to ASTM E 329 for testing and inspections indicated.

- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel."
- C. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 360 "Specification for Structural Steel Buildings".
 - 2. AISC 303 "Code of Standard Practice for Steel Buildings and Bridges"
 - 3. AWS D1.1 "Structural Welding Code – Steel"
 - 4. RCSC "Specification for Structural Joints Using High-Strength Bolts"

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.6 COORDINATION

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992 Grade 50.
- B. Channels, Angles: ASTM A 36.
- C. Plate and Bar: ASTM A 36.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B.
- E. Steel Pipe: ASTM A 53, Grade B.
- F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM F 3125, Grade 325, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel

washers.

1. Finish: Plain.

B. Anchor Bolts: ASTM F1554, Grade 36 ksi, headed heavy hex or headless steel anchor bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Hot-Dip Galvanized.

2.3 PRIMER

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

B. Galvanizing Repair Paint: ASTM A 780.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Minimum compressive strength shall be 5000 psi at 28 days.

2.5 FABRICATION

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

1. Camber structural-steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6 and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.

1. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
2. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High Strength Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Surfaces to receive sprayed fire-resistive materials.
 - 4. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
 - 1. Fill vent holes and grind smooth after galvanizing.
 - 2. Galvanize all lintels supporting exterior walls, exterior shelf angles, and all exterior exposed steel.

2.9 SOURCE QUALITY CONTROL

- A. Engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the

Contract Documents.

- C. Bolted Connections: All shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using High Strength Bolts."
 - 1. Bearing type connections: periodic
 - 2. Slip critical connections: continuous
- D. Welded Connections: In addition to visual inspection, 25% of shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Specification for Structural Steel Buildings" and "Code of Standard Practice for Steel Buildings and Bridges".
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of base plate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed.

- Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using High Strength Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

3.5 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Engage an independent qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- B. Inspections:
1. Verification of materials for high strength bolts, nuts and washers.

2. High-strength bolting.
3. Verification of materials for structural steel members.
4. Verification of materials for weld filler materials.
5. Welding.
6. Steel frame joint details.

C. High-Strength Bolting:

1. All field- and shop-bolted connections shall be visually inspected according to RCSC's "Specification for Structural Joints Using High Strength Bolts."
 - a. Bearing type connections: periodic
 - b. Slip critical connections: continuous
2. In addition to visual inspection, 25% of all field-installed bolts shall be checked with a calibrated torque wrench.

D. Welding:

1. All field-welded connections shall be visually inspected according to AWS D1.1.
2. In addition to visual inspection, 25% of all field welds and 100% of all groove welds shall be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.

E. Steel Frame Joint Details: Inspection of steel framing for compliance with the Contract Documents shall include:

1. Member locations
2. Application of appropriate connection details.
3. Details such as bracing and stiffeners.

F. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

NORTH POINT LIBRARY HVAC
Contract Number: 24146PO0
Job Order Number: 10000216

October 15, 2024
Final Construction Documents Submission

END OF SECTION 051200

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Framing with dimension lumber.
 - 2. Wood blocking.
 - 3. Fasteners for attaching any device, equipment signage, decoration, or other wall-mounted accessory to gypsum board wall construction.
- B. Related Sections:
 - 1. Section 064023 "Interior Architectural Woodwork" for shop-fabricated interior woodwork and other nonstructural carpentry items exposed to view and not specified in another Section.

1.3 DEFINITIONS

- A. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NHLA: National Hardwood Lumber Association.
 - 3. NLGA: National Lumber Grades Authority.
 - 4. SPIB: The Southern Pine Inspection Bureau.
 - 5. WCLIB: West Coast Lumber Inspection Bureau.
 - 6. WWPA: Western Wood Products Association.
- B. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise specified. All rough carpentry materials incorporated into this Project are to be fire-retardant-treated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 2. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
 - 3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, showing compliance with building code in effect for the project:
 1. Fire-retardant-treated wood.
 2. Metal framing anchors.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated and acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack materials on treated or non-decaying skids sized and arranged as to support the material without producing noticeable distortion and to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
 1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.
- B. Storage areas shall be free of debris, decayed wood, and vegetation and shall have sufficient drainage to prevent treated wood products from contact with standing water.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
 1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 4. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.2 FIRE-RETARDANT-TREATED MATERIALS

- A. General: All rough carpentry materials shall be fire-retardant-treated wood and shall comply with applicable requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection Inc., or another testing and inspecting agency acceptable to authorities having jurisdiction.
1. Research or Evaluation Reports: Provide fire-retardant-treated wood acceptable to authorities having jurisdiction and for which a current model code research or evaluation report exists that evidences compliance of fire-retardant-treated wood for application indicated.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Use treatment that does not promote corrosion of metal fasteners.
2. Interior Type A: For interior locations, use chemical formulation that produces treated lumber and plywood with the following properties under conditions present after installation:
- a. Bending strength, stiffness, and fastener-holding capacities are not reduced below values published by manufacturer of chemical formulation under elevated temperature and humidity conditions simulating installed conditions when tested by a qualified independent testing agency.
- b. No form of degradation occurs due to acid hydrolysis or other causes related to treatment.
- c. Contact with treated wood does not promote corrosion of metal fasteners.
- d. 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) Arch Wood Protection, Inc.
- 2) Hoover Treated Wood Products, Inc.
- 3) Universal Forest Products.
- 4) Viance.
- C. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
- D. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- E. Application: Treat all miscellaneous carpentry including, but not limited to, the following, unless otherwise indicated:
1. Concealed blocking.
2. Roof framing and blocking.
3. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
4. Plywood backing panels.

2.3 BOARDS

- A. Concealed Boards: Where boards will be concealed by other work, provide lumber with 19 percent maximum moisture content and of the following species and grade:
1. Species and Grade: Western woods, Standard per WCLIB rules or No. 3 Common per WWPA rules.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
 2. Nailers.
 3. Furring.
 4. Stripping.
- B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown on the Drawings.
- C. Moisture Content: 19 percent maximum for lumber items not specified to receive wood-preservative treatment.
- D. For items of dimension lumber size, provide Standard, or No. 3 grade lumber per ALSC's NGRs of any species.
- E. For board-size lumber, provide No. 3 Common grade per NELMA, NLGA, or WWPA; No. 2 grade per SPIB; or Standard grade per NLGA, WCLIB, or WWPA of any species.

2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M of Type 304 stainless steel.
- B. Nails, Brads, and Staples: ASTM F 1667.
1. For fastening lumber to lumber, provide cement-coated or annular (ringed-shank) threaded nails of sufficient length to penetrate a minimum of 1-1/4-inch into adjoining members, or stove or lag bolts used with washers.
 2. For fastening plywood to lumber, provide annular (ringed-shank) threaded nails; 8d for 1/2-inch-thick plywood and 10d for 3/4-inch-thick plywood.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

- F. Lag Bolts: ASME B18.2.1.
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
- I. Fasteners for Gypsum Wall Construction: For attaching any device, equipment signage, decoration, or other wall-mounted accessory to gypsum wall construction, provide one of the following:
 - 1. Single-Layer Gypsum Board Wall Construction:
 - a. "Molly" sleeve-type hollow wall anchors.
 - b. One-piece self-drilling anchors or nylon or alloy construction for light and medium loads such as ITW Buildex E-Z Anchor Self-Drilling Drywall Anchor.
 - c. Self-drilling single-point metal toggle for heavy duty loads such as ITW Buildex E-Z Toggle.

2.6 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
 - 1. All adhesives used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following requirements as applicable to the Project scope:
 - a. Adhesives must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168 effective date of July 1, 2005 and rule amendment date of January 7, 2005.
 - b. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.
 - c. Adhesives shall contain no carcinogen or reproductive toxicant components present at more than 1 percent of total mass of the product as defined in the California Office of Environmental Health Hazard Assessment's (OEHHA) list entitled "Chemicals Known to the State to Cause Cancer" or the Reproductive Toxicity, Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65).
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- C. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.
- D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven staples, P-nails, and allied fasteners.
 - 2. "Recommended Nailing Schedule" of referenced framing standard and with AFPA's "National Design Specifications for Wood Construction."
- E. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; pre-drill as required.
- F. Use hot-dip galvanized or stainless steel nails where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity.
- G. Countersink nail heads on exposed carpentry work and fill holes with wood filler.
- H. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- I. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- J. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block concealed spaces of wood-framed walls and partitions at each floor level and at ceiling line of top story. Where fire blocking is not inherent in framing system used, provide closely fitted wood blocks of 2-inch nominal (38-mm actual) thickness lumber of same width as framing members.
- K. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- L. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- M. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

- N. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD FRAMING, GENERAL

- A. Framing Standard: Comply with AFPA's "Manual for Wood Frame Construction," unless otherwise indicated.
- B. Install framing members of size and at spacing indicated.
- C. Frame openings as indicated.
- D. Do not splice structural members between supports.

3.3 BLOCKING INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

3.4 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

3.5 INSTALLATION OF PLYWOOD BACKING PANELS

- A. Nail or screw plywood backing panels to supports.

3.6 INSTALLATION OF FASTENERS FOR WALL-MOUNTED ACCESSORIES TO GYPSUM WALL CONSTRUCTION

- A. Whenever possible, objects shall be mounted to gypsum board wall construction by aligning the fastening point at and into a supporting member (stud or channel), solid blocking (consisting of fire-retardant-treated wood blocking or metal grounds), or grounds in order to avoid the need for any form of thru-wall anchor.

B. Where fastening to framing or blocking as described above is not possible, the following methods shall be used:

1. For concealed spaces or utility spaces not exposed to public view, attach fire-retardant-treated wood blocking or plywood backing on the face of the drywall to the metal studs or wall framing as described above, then attach the device or equipment to the backing.
2. For exposed and finished areas exposed to public view, including patient room and procedure areas, use only approved types of wall anchors as specified. Only nylon or metal anchors of the types specified may be used. It is the installer's responsibility to select an anchor of appropriate type and capacity for the weight of the object and manner of attachment, and sized for the thickness of the gypsum board.
3. Installation:

a. Single-Layer Gypsum Board Wall Construction:

- 1) "Molly" Sleeve-Type Hollow Wall Anchors: Gypsum board wall construction must be drilled to accept this type of fastener; driving or hammering the fastener through the gypsum board is not permitted.
 - 2) One-Piece Self-Drilling Anchors or Nylon or Alloy Construction: This fastener is screwed into the wall construction, then receives a screw that expands the anchor in the gypsum board.
 - 3) Self-Drilling Single-Point Metal Toggle for Heavy Duty Loads: This fastener is screwed into the wall construction, and then received a screw that deploys the toggle element and draws it tight to the back of the wallboard.
4. Do not exceed more than 30 fasteners penetrating the gypsum board in a 50 square foot area of fire-rated wall. For installations requiring a higher concentration of fasteners, contact the Owner for instruction prior to proceeding.
- a. This criteria is not intended to limit a maximum of 1.66 fasteners per square foot, but is to limit the overall number of fasteners in a given area of wall.

3.7 PROTECTION

A. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 072200 - ROOF DECK INSULATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and contract documents.

1.2 SECTION INCLUDES

- A. Wood fiberboard and polyisocyanurate roof board types and applications. Roof section application and layout requirements.

1.3 RELATED SECTIONS

- A. Section 075115 Hot Built Up Roofing
- B. Section 076200 Sheet Metal Flashing and Trim

1.4 REFERENCES

- A. ASTM C 208 Cellulose Fiber Insulating Board
- B. ASTM C 1289 Polyisocyanurate Insulating Board
- C. UL Roofing and Materials Directory 2003, Underwriters Laboratories Inc.
- D. Factory Mutual Global – Approval Guide
- E. RIC/TIMA Technical Bulletin 281-1 - Roof Insulation Specimen Conditioning Procedure, The Roof Insulation Committee of the Thermal Insulation Manufacturers Association, Mt. Kisco, NY.

1.5 SUBMITTALS

- A. Contractor shall provide the following: Product data sheets shall accompany samples.
 - 1. Product data sheets for all polyisocyanurate insulation and all accessory products.
 - 2. Product data for all adhesives and fasteners.
 - 3. Fastener pattern plans
 - 4. Gypsum coverboard
 - 5. Shop drawings for the tapered insulation plan per roof section
- B.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials:
 - 1. Deliver materials to job-site in new, dry, unopened and well-marked containers showing product and manufacturers name.
 - 2. Deliver materials in sufficient quantity to allow continuity of work.
 - 3. Coordinate delivery with project superintendent.
 - 4. Do not order project materials or start work before receiving written notice to proceed. No work shall commence without signed contracts.
- B. Storage of Materials:
 - 1. Store rolled goods on ends only. Place materials on pallets. Do not stack pallets.
 - 2. Store materials marked "KEEP FROM FREEZING" in areas where temperatures will remain above 40° F.
 - 3. For insulation, remove plastic packaging shrouds. Cover top and sides of all stored materials with tarpaulin (not polyethylene). Secure tarpaulin.
 - 4. Rooftop storage: Disperse material to avoid concentrated loading.
 - 5. Do not store materials in open or in contact with ground or roof surface.

6. Store all materials on a raised platform covered with secured canvas tarpaulin (not polyethylene), top to bottom. Cover all materials when project is not in progress and maintain the ability at all times to cover the materials when required, such as during an unanticipated rain shower.
 7. Contractor shall assume full responsibility for the protection and safekeeping of products stored on premises.
- C. Material handling:
1. Handle materials to avoid bending, tearing, or other damage during transportation and installation.
 2. Material handling equipment shall be selected and operated so as not to damage existing construction or applied roofing. Do not operate or situate material handling equipment in location that will hinder smooth flow of vehicular or pedestrian traffic.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Environmental requirements:
1. Do not work in rain, snow, or in presence of water.
 2. Do not work in temperatures below 40° F.
 3. Do not install materials marked "KEEP FROM FREEZING" when daily temperatures are scheduled to fall below 40° F.
- B. Remove any work exposed to freezing.
1. Advise Owner when volatile materials are to be used near air ventilation intakes so Owner can use some or all of the following methods to minimize disruptions to building occupants and operations:
 - a. Divert air intake from work area by attaching scoops or temporary ductwork.
 - b. Temporarily shut down or block air intakes.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Comply with quality control, references, specifications, and manufacturer's data. Products containing asbestos are prohibited on this project. Use only asbestos-free products.
- B. Use products with personal protection. User must read container label and material safety data sheets prior to use.

2.2 ACCEPTABLE MANUFACTURERS

- A. Use only approved Polyisocyanurate board. Acceptable manufacturers include:
1. Hy-Therm AP by Celotex
 2. ENERGY-2 by Johns Manville
 3. ISO95+GL by Firestone
 4. Polyisocyanurate by Hunter Panels
 5. AC Foam-II by Atlas
 6. Approved equal by Owner.

2.3 MATERIALS

- A. Base Tapered Polyisocyanurate Board Insulation:
1. FS HH-I-1972 (1) Class 1, factory-tapered isocyanurate.
 2. Black, glass fiber reinforced, non-asphaltic facer.
 3. Dimensions: 4 by 8 by 2.5" max thickness per layer.
 4. R-value shall R-30 minimum average unless otherwise indicated due to flashing height restrictions.
- B. Tapered Polyisocyanurate Insulation:
1. FS HH-I-1972 (1) Class 1, tapered isocyanurate.

2. Black, glass fiber reinforced, non-asphaltic facer
 3. Dimensions: 4 by 4 feet.
 4. Provide factory-tapered insulation boards fabricated to minimum of 1/4 inch per foot.
- C. Tapered Polyisocyanurate Saddle and Cricket Insulation:
1. FS HH-I-1972 (1) Class 1, tapered isocyanurate.
 2. Black, glass fiber reinforced, non-asphaltic facer
 3. Dimensions: 4 by 4 feet.
 4. Provide factory-tapered insulation boards fabricated to slope of twice (2 times) the roof system slope, with a minimum of 1/2 inch per foot.
- D. Cover Board:
1. Securock by USG Corporation or APPROVED EQUAL.
 - a. ASTM C 1278/C 1278M, cellulosic-fiber water-resistant gypsum substrate.
 2. Dimensions:
 - a. 4 by 4 feet by 3/8 inch thick.
- E. Tapered Edge Strips:
1. ASTM C 208, asphalt-coated fiberboard, tapered from 1-5/8 inch to 1/8 inch.
 - a. Dimensions: 12" x 48".
- F. Fibered Cant Strips:
1. ASTM C 208-95, asphalt-coated fiberboard, factory fabricated.
 2. Dimensions: 4 by 4 inch cut on bias.
- G. Insulation Roof Board Adhesive:
1. Type III Hot Asphalt: (Hot Applied Built Up Roof)
 - a. Hot melt asphalt adhesive exceeding ASTM D 312-95a performance requirements.
 2. Solvent Free Insulation Adhesive: (Cold Applied Built Up Roof)
 - a. Solvent free, asbestos free, one part, no odor insulation adhesive.
- H. Roof insulation accessories:
1. As recommended by insulation manufacturer for intended use and compatible with membrane roofing.

PART 3 — EXECUTION

3.1 EXAMINATION

- A. Verify conditions as satisfactory to receive work.
- B. Do not begin roofing until all unsatisfactory conditions are corrected. Beginning work constitutes acceptance of conditions.
- C. Verify that work of other trades penetrating roof deck or requiring men and equipment to traverse roof deck has been approved by Owner, manufacturer, and roofing contractor.
- D. Check projections, curbs, and deck for inadequate anchorage, foreign material, moisture, or unevenness that would prevent quality and execution of new roofing system.

3.2 GENERAL WORKMANSHIP

- A. All work performed by contractor shall conform to this specification.
- B. The presence and activity of the manufacturer's representative, architect's representative, and/or Owner's representative shall in no way relieve contractor of contract responsibilities or duties.
- C. Substrate: Free of foreign particles prior to laying roof insulation.
- D. Wrapper and packaging materials: Not to be included in roofing system.
- E. Insulation: Form continuous insulation joints over decking.
- F. Install insulation boards in courses parallel to roof edges.

- G. Firmly butt each insulation board to surrounding boards. Do not jam or deform boards.
- H. Eliminate open joints and uneven surfaces.
 - 1. Maximum insulation gap: 1/4 inch.
 - 2. Fill insulation board joint gaps larger than 1/4 inch with roof insulation.
 - 3. Maximum elevation variation between boards at joints: 1/8 inch.
- I. Cut and fit insulation boards where roof deck intersects vertical surfaces. Cut board 1/4 inch from vertical surface.
- J. Stagger joints at least 6 inches.
- K. Filler size: 18 inches in length or width, minimum.

3.3 PREPARATION

- A. Protection:
 - 1. Contractor shall be responsible for protection of property during course of work. Lawns, shrubbery, paved areas, and building shall be protected from damage. Repair damage and/or clean marred areas at no extra cost to owner.
 - 2. Provide at site prior to commencing removal of debris, a dumpster or dump truck to be located adjacent to building where directed by owner.
 - 3. Roofing, flashings, membrane repairs, and insulation shall be installed and sealed in a watertight manner on same day of installation or before arrival of inclement weather.
 - 4. At start of each work day drains within daily work area shall be plugged. Plugs to be removed at end of each workday or before arrival of inclement weather. Preparation work shall be limited to those areas that can be covered with installed roofing material on same day and before arrival of inclement weather.
 - 5. Arrange work sequence to avoid use of newly constructed roofing for storage, walking surface, and equipment movement. Move equipment and ground storage areas as work progresses.
 - 6. Protect building surfaces at set-up areas with tarpaulin. Secure tarpaulin. Remove dumpster from premises when full and empty at approved dumping or refuse area. Deliver empty dumpster to site for further use. Upon job completion, dumpster shall be removed from premises. Spilled or scattered debris shall be cleaned-up immediately. Removed material to be disposed from roof as it accumulates.
 - 7. At end of each working day, seal removal areas with water stops along edges to prevent water entry.
 - 8. Provide clean plywood walkways and take other precautions required to prevent tracking of aggregate/debris from existing membrane into new work area where aggregate/debris pieces can be trapped within new roofing membrane. Contractor shall instruct and police workmen to ensure that aggregate/debris is not tracked into new work areas on workmen's shoes or equipment wheels. Discovery of entrapped aggregate/debris within new membrane is sufficient cause for its rejection.
- B. Asphalt heating:
 - 1. Maximum asphalt temperature: 25 degrees F below the flash point.
 - 2. Avoid prolonged heating of asphalt at high temperatures. Reduce the asphalt temperature to below 500 degrees F if asphalt is not being used for periods of 4 hours or more.
 - 3. Tanker: Free of contaminants.
 - 4. Application rates: Bitumen quantities for water stop/tie-offs, flashings, miscellaneous detail applications, and minimum kettle capacity are not included in application rates. Mopping rate - 25 pounds per 100 square feet plus or minus 20 percent.
 - 5. Heat and apply asphalt in accordance with equiviscous temperature (EVT) melted as recommended by NRCA. Temperature shall be EVT plus or minus 25 degrees at point of application. Discard bitumen that does not fall within this standard.
- C. Surface preparation:
 - 1. Sweep clean roof deck.
 - 2. Install pressure treated wood nailers as required to match new insulation height.

3.4 INSTALLATION

- A. Install new tapered roof insulation system. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.
1. General Requirements:
 - a. **The minimum insulation average R-Value requirement for the project is R-30. The installed insulation thickness shall be adjusted as required to meet or exceed the roof insulation systems specified R-Value requirement min. thickness.**
 - b. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards.
 - c. Fill gaps exceeding 1/4 inch with insulation.
 - d. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - e. Install insulation system in application of solvent free insulation adhesive with beads at 12" o.c per manufacturer's recommendations. Let adhesive rise. Walk insulation boards into adhesive immediately after placement to achieve solid contact
 - f. Immediately after placement, walk insulation boards into adhesive to achieve solid contact.
 2. Install base tapered polyisocyanurate insulation system.
 - a. Install tapered polyisocyanurate insulation with 1/4 inch per foot slope except where 1/8 inch per foot slope is shown present in existing deck, or as indicated on drawings.
 - b. Minimum insulation thickness as required to meet the specified insulation system R-Value requirement.
 - c. Install 4 by 4 ft. tapered insulation sumps at roof drains.
 3. Install tapered insulation saddles or crickets to promote positive drainage along valley lines between roof drains and scuppers, along walls, at high side of roof curbs.
 - a. Install tapered polyisocyanurate insulation with minimum 1/2-inch per foot slope.
 - b. Tapered insulation saddle and cricket slope shall equal a minimum of twice the roof slope.
 - c. Saddle widest width shall equal or exceed 1/3 of the distance between the roof drains or scuppers.
 - d. Contractor is responsible for the elimination of ponding water along valley lines.
 4. Install tapered edge strips where blocking height exceeds insulation height.
- B. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- C. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- D. If metal deck mechanically fasten base layer with metal deck fasteners and discs that meet Factory Mutual requirements. Mechanically fasten insulation to metal deck to meet FM 1-90 requirements.
- E. Adhere subsequent layers of polyisocyanurate insulation in continuous application of hot asphalt at 30 pds per 100 sq ft per layer if hot applied roofing system and application of solvent free insulation adhesive at 2 gal per 100 sq ft if cold applied roofing system.
- F. Install tapered saddles and Crickets.
 1. Adhere tapered insulation to base insulation layer with a uniform and continuous application of Hot Asphalt at 30 pds per 100 sq ft if hot applied roofing system and application of solvent free adhesive at 2 gal per 100 sq ft if cold applied roofing system.
- G. Install top layer insulation layer.

1. Adhere insulation over bottom layer insulation with a uniform and continuous application of Hot Asphalt at 30 pds per 100 sq ft if hot applied roofing system and application of solvent free adhesive at 2 gal per 100 sq ft if cold applied roofing system.
 2. Offset joints of second layer 6 inches in both directions from joints of base layer.
- H. Install tapered edge strips.
1. Adhere tapered edge strips over top layer insulation with a uniform and continuous application of Hot asphalt.
- I. Install fibered cant strips.
1. Adhere 45 degrees and continuous cants (4 by 4's) at intersections of horizontal and vertical flashing surfaces with a uniform and continuous application of Hot Asphalt if hot applied roofing system and application of solvent free adhesive at 2 gal per 100 sq ft if cold applied roofing system.

END OF SECTION 072200

SECTION 075113 - BUILT-UP ASPHALT ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Built-up asphalt roofing with aggregate ballast.
 - 2. Roof insulation.
- B. Related Sections:
 - 1. Division 7 Section for Sheet Metal Flashing

1.3 DEFINITIONS

- A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to built-up roofing.
- B. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F, measured at the mop cart or mechanical spreader immediately before application.

1.4 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed built-up roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Built-up roofing and base flashings shall remain watertight.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by built-up roofing manufacturer based on testing and field experience.
- C. FM Approvals Listing: Provide built-up roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a built-up roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
 - 1. Fire/Windstorm Classification: Class 1A-90.
 - 2. Hail Resistance Rating: SH.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated including roof drains. Data showing the flood coat and gravel meets or exceeds the LEED requirements.
- B. Shop Drawings: For built-up roofing. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Base flashings and built-up terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Crickets, saddles, and tapered edge strips, including slopes.
 - 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- C. Samples for Verification: For the following products:
 - 1. Built-up roofing materials, including ply sheet, cap sheet and flashing sheet, of color specified.
 - 2. Roof insulation.
 - 3. 3 lb of aggregate surfacing material in gradation indicated.
 - 4. Six insulation fasteners of each type, length, and finish.
- D. Qualification Data: For qualified Installer and manufacturer.
- E. Manufacturer Certificates: Signed by roofing manufacturer certifying that built-up roofing complies with requirements specified in "Performance Requirements" Article.
 - 1. Submit evidence of compliance with performance requirements.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of built-up roofing.
- G. Maintenance Data: For built-up roofing to include in maintenance manuals.
- H. Warranties: Sample of special warranties.
- I. Inspection Report: Roofing system manufacturer's inspection report of complete roofing installation.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is FM Approvals approved for built-up roofing identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by built-up roofing manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- C. Contractor will acquire an inspector employed by the manufacturer for full time inspection 8 hours each production day. The inspector must be an employee of the manufacturer for not less than 5 years. Daily reports will be provided to project manager
- D. Source Limitations: Obtain components including roof insulation, fasteners for built-up roofing from same manufacturer as built-up roofing or approved by built-up roofing manufacturer.

- E. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical built-up roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
- F. Pre-installation Roofing Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing.
 - 7. Review governing regulations and requirements for insurance and certificates if applicable.
 - 8. Review temporary protection requirements for roofing during and after installation.
 - 9. Review roof observation and repair procedures after roofing installation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing to be installed according to manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of built-up roofing, metal wall panel

systems and metal roofing systems that fail in materials or workmanship within specified warranty period.

1. Special warranty includes built-up roofing membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof pavers, and all metal components of built-up roofing, metal wall panels, metal roof system, and coping.
 2. A 20 year NDL, No Dollar Limit, warranty will be provided for the Built-up roof and all components, Metal Roof System, and Metal Wall Panels. The total roof system warranty for all the roofs will be provided by one manufacturer. All roof components of each roofing system will be provided by one manufacturer.
 3. Warranty Period: 20 years from date of Substantial Completion. In years 2, 5, 7, 10, and 15 Manufacturer will inspect, clean the roof of all debris, and perform any necessary maintenance. A report with photographs will be generated explaining the roof inspection, what was found and debris that was removed from the roof, and the maintenance that was performed.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of built-up roofing such as built-up roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BUILT-UP ROOFING MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide all products by one of the following:
1. GAF Materials Corporation.
 2. Johns Manville.
 3. Tremco, Incorporated.
 4. Or Approved Equal.

2.2 ROOFING MEMBRANE PLIES

- A. Base Ply Sheet and First Ply Sheet: **Tremco, BURmastic Composite Ply HT: Or APPROVED EQUAL** Nonperforated, asphalt-coated, polyester/fiberglass/polyester reinforced sheet dusted with fine mineral surfacing on both sides which meets the requirements of ASTM D 4601, Type II, and the following properties:
1. Breaking Strength, minimum, ASTM D 146: machine direction, 135 lbf/in; cross machine direction, 130 lbf/in.
 2. Tear Strength, minimum, ASTM D 4073: machine direction, 220 lbf; cross machine direction, 215 lbf.
 3. Pliability, 1/2 inch radius bend, ASTM D 146: No failures.
 4. Thickness, minimum, ASTM D 146: 0.055 inch.
 5. Weight, minimum, ASTM D 228: 31 lb/100 sq. ft.
 6. Mass of desaturated polyester/glass/polyester mat, ASTM D 228: 2.2 lb/100 sq. ft.
 7. Asphalt, minimum, ASTM D 228: 10 lb/100 sq. ft.

- B. Ply Sheet: ASTM D 2178, Type VI, asphalt-impregnated, glass-fiber felt.

2.3 BASE FLASHING SHEET MATERIALS

- A. Hypalon Elastomeric Sheeting.
 - 1. Elastomeric sheeting compounded from Hypalon elastomer laminated to high strength polyester reinforcing scrim and meets the requirements of ASTM D 5019, Type I, Grade II, CSPE sheet.
 - 2. Thickness: .045 inch.
- B. Hypalon Flashing Adhesive.
 - 1. Solvent-Free Elastomeric Roofing Mastic: One-part, solvent-free, asbestos-free, low-odor elastomeric roof mastic specially formulated for compatibility and use with specified roofing membranes and flashings. No Bonding Adhesive or Solvent Free Bonding Adhesive can be used.

2.4 ASPHALT MATERIALS

- A. Asphalt Primer: ASTM D 41.
- B. Roofing Asphalt: ASTM D 312, Type III or IV as recommended by built-up roofing manufacturer for application. Asphalt must have the "no smell" additive. No kettles can be used only Asphalt Tankers

2.5 AUXILIARY BUILT-UP ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing manufacturer for intended use and compatible with built-up roofing.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.
- C. Mastic Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.
- D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening built-up roofing components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing manufacturer.
- E. Metal Flashing Sheet: Metal flashing sheet is specified in Division 7 Section "Sheet Metal Flashing and Trim."
- F. Miscellaneous Accessories: Provide miscellaneous accessories recommended by built-up roofing manufacturer.

2.6 WALKWAYS

1. Roof Walkways: Mineral-surfaced asphaltic composition panels, factory formed, non-porous, with slip-resisting surface texture, manufactured specifically for adhering to built-up roofing as a protection course for foot traffic.

2.7 COATING MATERIALS

- A. Flashing Coating:
 1. Type I, heat-reflective, non-fibered, aluminum pigmented roof coating that meets the requirements of ASTM D 2824.
 2. Two (2) coats
- B. Flood Coat and Aggregate Surfacing :
 1. Flood coat shall be Burmastic Adhesive by Tremco **or Approved Equal**. A cold applied Type 1 surfacing adhesive.
 2. Provide aggregate surfacing that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation, of the following type and size:
 2. Texas # 7 White Highly Reflective Marble Roofing Aggregate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
 2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 BASE SHEET INSTALLATION

- A. Remove existing roof and insulation to the existing two ply temporary roof.
- B. Nail the existing two ply temporary roof to the deck with 1.8" length and 2.7" disc Twin Loc-Nail to meet FM 1-90 wind uplift requirements.

- C. Apply specified base ply to the nailed two ply membrane with 30 pounds per 100 sq ft of hot asphalt.

3.4 INSULATION INSTALLATION

- A. Comply with built-up roofing manufacturer's written instructions for installing roof insulation.
- B. Install tapered insulation under area of roofing to conform to slopes indicated.
- C. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
 - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Set each subsequent layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
- G. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together and fasten to roof deck. Tape joints if required by roofing manufacturer.
 - 1. Apply hot roofing asphalt to underside and immediately bond cover board to substrate.

3.5 BUILT-UP ROOFING INSTALLATION, GENERAL

- A. Install roofing membrane according to roofing manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
 - 1. Install roofing system BU-4-I-A-A, according to roof assembly identification matrix and roof assembly layout illustrations in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.
- B. Start installation of built-up roofing in presence of manufacturer's technical personnel.
- C. Cooperate with testing agencies engaged or required to perform services for installing roofing.
- D. Coordinate installation of roofing so insulation and other components of built-up roofing not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.
 - 1. Provide tie-offs at end of each day's work to cover exposed built-up roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.

2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.
 3. Remove and discard temporary seals before beginning work on adjoining roofing.
- E. Asphalt Heating: Do not raise roofing asphalt temperature above equiviscous temperature range more than one hour before time of application. Do not exceed roofing asphalt manufacturer's recommended temperature limits during roofing asphalt heating. Do not heat roofing asphalt within 25 deg F of flash point. Discard roofing asphalt maintained at a temperature exceeding finished blowing temperature for more than 4 hours.
- F. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging built-up roofing components or adjacent building construction.

3.6 ROOFING MEMBRANE INSTALLATION

- A. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
1. Adhere to substrate in a solid mopping of hot roofing asphalt.
- B. Install three ply sheets starting at low point of roofing. Align ply sheets without stretching. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane. Shingle in direction to shed water. Extend ply sheets over and terminate beyond cants.
1. Embed each ply sheet in a solid mopping of hot roofing asphalt applied at rate required by roofing manufacturer, to form a uniform membrane without ply sheets touching.
- C. Aggregate Surfacing: Promptly after installing and testing roofing membrane, base flashing, and stripping, flood-coat roof surface with 5 gal/100 sq. ft. of cold applied flood coat. While flood coat is fluid, cast the following average weight of aggregate in a uniform course:
1. Aggregate Weight: 550 lb/100 sq. ft.
 2. If aggregate surfacing is delayed, promptly apply glaze coat of hot roofing asphalt at a rate of 20 lb/100 sq. ft..

3.7 FLASHING AND STRIPPING INSTALLATION

- A. Install base flashing over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to built-up roofing manufacturer's written instructions and as follows:
1. Prime substrates with asphalt primer if required by built-up roofing manufacturer.
 2. Flashing Sheet Application: Adhere flashing sheet to substrate in a full application of solvent free flashing adhesive.
 3. Revise dimensions in first paragraph below if required. Verify minimum and maximum height limits with manufacturers if necessary. NRCA recommends a minimum base-flashing height of 8 inches (200 mm) and a maximum of 24 inches (600 mm).
- B. Extend base flashing up walls or parapets a minimum of 8 inches above built-up roofing and 4 inches onto field of built-up roofing. At parapet walls hypalon flashing will extend up and over top of parapet wall and nailed off to back side.
- C. Install term bar and mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

- D. At interior of perimeter parapet wall coping stone extends 1" past brick. Remove existing 1 inch rigid fiberglass and mechanically fasten into brick 1" pressure treated plywood. Then install cant and flashing.
 - 1. Seal top termination of base flashing with a strip of glass-fiber fabric set in asphalt roofing cement.
- E. Install stripping, according to roofing manufacturer's written instructions, where metal flanges and edgings are set on built-up roofing.
 - 1. Built-up Stripping: Install stripping of not less than two roofing membrane ply sheets, setting each ply in a continuous coating of asphalt roofing cement or in a solid mopping of hot roofing asphalt, and extend onto roofing membrane 4 inches and 6 inches, respectively.
 - 2. After hypalon is installed coat the hypalon with 2 coats of aluminum reflective coating at 130 sq ft per gal per coat.
- F. Roof Drains: Set 30-by-30-inch metal flashing in bed of asphalt roofing cement on completed built-up roofing. Cover metal flashing with built-up roofing cap-sheet stripping and extend a minimum of 6 inches beyond edge of metal flashing onto field of built-up roofing. Clamp built-up roofing, metal flashing, and stripping into roof-drain clamping ring.
 - 1. Install stripping according to roofing manufacturer's written instructions.

3.8 WALKWAY INSTALLATION

- A. Roof Walkways: Install walkway at access points only according to roofing manufacturer's written instructions in locations indicated, to form walkways. Clean roof membrane surface with Low volatile primer. Spot adhere walkways with asphaltic mastic.

3.9 PROTECTING AND CLEANING

- A. Protect built-up roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove built-up roofing that does not comply with requirements, repair substrates, and repair or reinstall roofing to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
 - 1. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction

END OF SECTION 075113

SECTION 076200 - SHEET METAL FLASHING AND TRIM

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. Counter flashing.

- B. Related Sections:

- 1. Division 07 Section "Roof Accessories" for set-on-type curbs, equipment supports and other manufactured roof accessory units.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual & SMACNA's "Architectural Sheet Metal Manual requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure
- D. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
 - 1. Wind Zone 2: For velocity pressures of 31 to 45 lbf/sq. ft.: 90-lbf/sq. ft. perimeter uplift force, 120-lbf/sq. ft. corner uplift force, and 45-lbf/sq. ft. outward force.
- E. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

- F. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
 - 1. Finish: No. 2D (dull, cold rolled).

2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by

manufacturer of primary sheet metal.

1. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- C. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.3 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."
- D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- E. Do not use graphite pencils to mark metal surfaces.

2.4 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Curb Counter Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch (0.48 mm)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
1. Verify compliance with requirements for installation tolerances of substrates.
 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely

anchored.

- B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
 - 5. Install sealant tape where indicated.
 - 6. Torch cutting of sheet metal flashing and trim is not permitted.
 - 7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
 - 1. Coat back side of stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- D. Seal joints as shown and as required for watertight construction.
 - 1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 - 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."
- E. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work.

1. Do not solder aluminum] sheets
2. Do not pre-tin zinc-tin alloy-coated stainless steel.
3. Do not use torches for soldering.
4. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
5. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

3.3 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.4 FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

3.5 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.6 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Roof curbs.
 - 2. Equipment Rails.
 - 3. Duct supports.
- B. Related Sections:
 - 1. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, and miscellaneous sheet metal trim and accessories.
 - 2. Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, gutters and downspouts, and counterflashing.

1.3 PERFORMANCE REQUIREMENTS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

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

1.7 COORDINATION

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

1.8 WARRANTY

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

PART 2 - PRODUCTS

2.1 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation and mill phosphatized for field painting where indicated.
1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
 2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 coated.

1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
- C. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.

2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, thickness as indicated.
- C. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.
- D. Polyisocyanurate Board Insulation: ASTM C 1289, thickness as indicated.
- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
 1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 3. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- I. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- J. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 ROOF CURBS

- A. Roof Curbs: Provide pre-fabricated insulated metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other

construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1. Manufacturers:
 - a. Curbs Plus Inc.
 - b. Custom Curb, Inc.
 - c. LM Curbs.
 - d. Pate Company
 - e. Roof Products, Inc.
 - f. ThyCurb Div. of Thybar Corporation
2. Load Requirements: 500 lbs.
3. Material: Galvanized steel sheet, 18 ga. thick.
4. Liner: Same material as curb, of manufacturer's standard thickness and finish.
5. Factory install wood nailers at tops of curbs.
6. Factory insulate curbs with 1-1/2-inch glass-fiber board insulation.
7. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height to maintain 8" roof clearance as indicated on the drawings, unless otherwise indicated.
8. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

2.4 EQUIPMENT SUPPORTS

- A. Equipment Supports for tapered insulation: Internally reinforced metal equipment curbs capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints and integrally formed deck-mounting flange at perimeter bottom.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Equipment Rail, RFS by Duravent; **ER-2A** or comparable product by one of the following:
 - a. Curbs Plus Inc.
 - b. Custom Curb, Inc.
 - c. LM Curbs.
 - d. Pate Company
 - e. Roof Products, Inc.
 - f. ThyCurb Div. of Thybar Corporation
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Load Requirements: 2500lbs Total Unit Weight . Submit load bearing tested and rated certification data with for submittal review.
- D. Material: 18 gauge **galvanized** steel.
- E. Construction:
 1. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.

2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
3. Factory-installed continuous wood nailers 3-1/2 inches wide at tops of equipment supports.
4. Counterflashing: Galvanized Steel
5. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
6. Fabricate equipment supports to minimum height of 16 inches unless otherwise indicated.

2.5 PIPE SUPPORTS

- A. Pipe Supports: Closed-cell polyethylene foam that is UV and weather resistant, and include a galvanized strut channel, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, and extruded-aluminum carrier assemblies; suitable for quantity of pipe runs and sizes.
1. Manufacturers: Subject to compliance with requirements, **provide products by one of the following, but are not limited to, the following:**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Ferguson FNW **Pipe Support, # FNW7701PP** or approved equal:
 3. Pipe Support Height: As indicated on Drawings.
 4. 14 Gauge Strut Channel, ASTM 570 Gr 33 and ASTM A653 Carbon Steel, Hot Dipped Mill Galvanized
 5. Base: Closed-Cell Medium Density Black Polyethylene Foam (Ethafoam® 400 plank

2.6 ROOF DUCT SUPPORT

- A. Duct Supports: Heavy gauge galvanized steel support rails and duct mounting hardware; with manufacturer's recommended hardware for mounting to structure or structural roof deck.
1. Manufacturers: Subject to compliance with requirements, **provide products by one of the following:**
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Pate Company, Duct Support System, DSS-2 or comparable product by one of the following:
 - a. Thaler Metal USA Inc.

2.7 GENERAL FINISH REQUIREMENTS

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.
 - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof Curb Installation: Install each roof curb so top surface is level.
- D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
- E. Pipe Support Installation: Install pipe supports so top surfaces are in contact with and provide equally distributed support along length of supported item.
- F. Security Grilles: Weld bar intersections and, using tamper-resistant bolts, attach the ends of bars to structural frame or primary curb walls.
- G. Preformed Flashing-Sleeve Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions.

- H. Seal joints with elastomeric butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078413 - THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire- resistance rating of construction penetrated.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:
 - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
 - a. Penetrations located outside wall or ceiling cavities.
 - b. Penetrations located outside fire-resistance-rated shaft enclosures
 - c. Penetrations exposed to view.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through- penetration firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
 - 4. For penetrations in humid environments such as Aquatics rooms and Cage Wash rooms, provide moisture resistant through-penetration firestop systems.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems exposed to view, except where Fire Barrier Pillow systems are specified, use systems capable of finish to the same texture as adjacent materials. Where adjacent surfaces are scheduled to be painted, provide through-penetration firestop systems capable of painting.

1.3 SUBMITTALS

- A. Required Approval by Authority Having Jurisdiction: Through-penetration firestop system

submittals will be reviewed by NIH Fire Protection Section (AHJ) concurrently with Project Officer's review. Notify Project Officer of any conflicting comments or requirements resulting from these two independent reviews.

- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations and system classification (identification), from Underwriters Laboratory or Factory Mutual, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.
 - 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Such proposed systems will be considered a Substitution Request subject to the terms and conditions established by these Specifications for same.
- D. Qualification Data: For Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."
- B. Installation Responsibility: Assign installation of through-penetration firestop systems in Project to a single qualified installer.
- C. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
 - 1. Firestopping tests are performed by Underwriters Laboratories or Factory Mutual.
 - 2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems bearing classification marking of qualified testing and inspecting agency.
- D. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- E. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by authorities having jurisdiction. This prohibition includes painting of firestop systems exposed to view.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Products: Products identified in following paragraphs are Basis of Design products. Subject to compliance with requirements, other through-penetration firestop systems that may be incorporated into the Work include, but are not limited to, those systems that are produced by one of the following manufacturers:
 - 1. A/D Fire Protection Systems Inc.
 - 2. Grace, W. R. & Co. - Conn.
 - 3. Hilti, Inc.
 - 4. Johns Manville.
 - 5. Nelson Firestop Products.

6. NUCO Inc.
7. RectorSeal Corporation (The).
8. Specified Technologies Inc.
9. 3M; Fire Protection Products Division.
10. Tremco; Sealant/Weatherproofing Division.
11. USG Corporation.

2.2 FIRESTOPPING

- A. System Selection: Choose appropriate firestop systems for each penetration of fire rated building elements from the following available firestop systems:
1. Firestop Compound: USG Corporation, Firecode Brand Compound
 - a. Powder or premixed with activator.
 - b. Non-toxic, not containing silicones, hologens, PCB's, asbestos or inorganic fibers of any kind.
 - c. Dries to red color to facilitate inspection.
 - d. Sandable and forming suitable substrate for latex or oil based paints.
 - e. Effectively bonds to metals, wood and cable jacketing without use of primers.
 2. Firestop Sealant: USG Corporation, Firecode Brand Acrylic Firestop Sealant, Type A
 - a. Sealant formulated for standard caulking equipment applications including metallic pipe, insulated pipe, copper tubing and pipe, and construction head-of-wall joints.
 - b. Integral red color to facilitate inspection.
 - c. Flexible, resistant to cracking.
 - d. Paintable with latex or oil based paints.
 3. Intumescent Firestop Sealant: USG Corporation, Firecode Brand Intumescent Acrylic Firestop Sealant, Type IA
 - a. Sealant formulated for standard caulking equipment applications of combustible materials such as plastic pipe and insulated pipe.
 - b. Materials expand when heated to fill any voids caused from combustible materials melted during fire event.
 - c. Integral red color to facilitate inspection.
 - d. Flexible, resistant to cracking.
 - e. Paintable with latex or oil based paints.
 - f. Intumescent Fire Barrier Pillows: 3M, Fire Protection Products Division, Fire Barrier Pillows Self contained, highly intumescent product designed to firestop a wide variety of through-penetrations including cable trays (up to two per opening), and multiple conduit pipe and blank openings.
 - g. Pillows are removable and replaceable to allow future additional penetrations.
 - h. Pillows are modular and allow relatively large openings through fire rated construction.
 - i. Where visible, limit use to openings indicated on drawings and to openings approved by Project Officer. Propose use of product wherever future flexibility including additional future penetrations is a desirable feature.
 - j. Integral red color to facilitate inspection.
- B. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- C. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 FIELD QUALITY CONTROL

- A. Inspecting Agency: Contractor will engage an independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.
- B. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.
- C. Proceed with enclosing through-penetration firestop systems with other construction or painting systems only after inspection reports are issued and firestop installations comply with requirements.

END OF SECTION 078413

SECTION 078446 - FIRE-RESISTIVE JOINT 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. Joints in or between fire-resistance-rated constructions.
 - 2. Joints in smoke barriers.
- B. Related Sections:
 - 1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."
- B. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

- C. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:
1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
 - a. Fire-resistive joint system products bear classification marking of qualified testing agency.
 - b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.
- C. Contractor to notify testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. A/D Fire Protection Systems Inc.
 - b. CEMCO.
 - c. Fire Trak Corp.
 - d. Grace Construction Products.
 - e. Hilti, Inc.
 - f. Johns Manville.
 - g. Nelson Firestop Products.
 - h. Passive Fire Protection Partners.
 - i. Specified Technologies Inc.
 - j. 3M Fire Protection Products.
 - k. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - l. USG Corporation.
- C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.
1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A/D Fire Protection Systems Inc.
 - b. Grace Construction Products.
 - c. Hilti, Inc.
 - d. Johns Manville.
 - e. Nelson Firestop Products.
 - f. Passive Fire Protection Partners.
 - g. Specified Technologies Inc.
 - h. 3M Fire Protection Products.
 - i. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - j. USG Corporation.
- D. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. VOC Content: Fire-resistive joint system sealants shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Architectural Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only

components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering- type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Designation of applicable testing agency.
 4. Date of installation.
 5. Manufacturer's name.
 6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.
- C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

FIRE-RESISTIVE JOINT SYSTEM SCHEDULE

C. Systems Listed Using Alpha-Alpha-Numeric Identification System in UL's *Fire Resistance Directory*, Vol. 2:

JOINT WIDTH		LESS THAN OR EQUAL TO 2 INCHES	GREATER THAN 2 INCHES AND LESS THAN OR EQUAL TO 6 INCHES	GREATER THAN 6 INCHES AND LESS THAN OR EQUAL TO 12 INCHES	GREATER THAN 12 INCHES AND LESS THAN OR EQUAL TO 24 INCHES	GREATER THAN 24 INCHES
TYPE OF JOINT	No Movement (S)	FF-S-0001-0999	FF-S-1001-4999	FF-S-2001-4999	FF-S-3001-3999	FF-S-4001-4999
	Have Movement (D)	FF-D-0001-0999	FF-D-1001-4999	FF-D-2001-4999	FF-D-3001-3999	FF-D-4001-4999
Wall-to-Wall (WW)	No Movement (S)	WW-S-0001-0999	WW-S-1001-4999	WW-S-2001-4999	WW-S-3001-3999	WW-S-4001-4999
	Have Movement (D)	WW-D-0001-0999	WW-D-1001-4999	WW-D-2001-4999	WW-D-3001-3999	WW-D-4001-4999
Floor-to-Wall (FW)	No Movement (S)	FW-S-0001-0999	FW-S-1001-4999	FW-S-2001-4999	FW-S-3001-3999	FW-S-4001-4999
	Have Movement (D)	FW-D-0001-0999	FW-D-1001-4999	FW-D-2001-4999	FW-D-3001-3999	FW-D-4001-4999
Head-of-Wall (HW)	No Movement (S)	HW-S-0001-0999	HW-S-1001-4999	HW-S-2001-4999	HW-S-3001-3999	HW-S-4001-4999
	Have Movement (D)	HW-D-0001-0999	HW-D-1001-4999	HW-D-2001-4999	HW-D-3001-3999	HW-D-4001-4999
Wall-to-Wall Joints Intended for Use as Corner Guards (CG)	No Movement (S)	CG-S-0001-0999	CG-S-1001-4999	CG-S-2001-4999	CG-S-3001-3999	CG-S-4001-4999
	Have Movement (D)	CG-D-0001-0999	CG-D-1001-4999	CG-D-2001-4999	CG-D-3001-3999	CG-D-4001-4999
For joints between fire-rated assemblies, provide UL-listed Joint Systems from applicable UL number range listed above that complies with this section and is suitable for joint conditions indicated.						

END OF SECTION 078446

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Latex joint sealants.
 - 4. Acoustical joint sealants.
- B. Related Sections:
 - 1. Section 092900 "Gypsum Board" for sealing perimeter joints.
 - 2. Section 095113 "Acoustical Panel Ceilings" for sealing edge moldings at perimeters with acoustical sealant.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
 - 1. Locate test joints where indicated on Project or, if not indicated, as directed by Owner.
 - 2. Conduct field tests for each application indicated below:
 - a. Each kind of sealant and joint substrate indicated.
 - 3. Notify Owner seven days in advance of dates and times when test joints will be erected.
 - 4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

- 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- B. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- C. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- D. Field-Adhesion Test Reports: For each sealant application tested.
- E. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.7 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Ten (10) years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Low-Emitting Materials:

1. Interior Sealants: All sealants and sealant primers used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) shall comply with South Coast Air Quality Management District (SCAQMD) Rule #1168 effective date of July 1, 2005 and rule amendment date of January 7, 2005.
 - a. Sealants shall contain no carcinogen or reproductive toxicant components present at more than 1 percent of total mass of the product as defined in the California Office of Environmental Health Hazard Assessment's (OEHHA) list entitled "Chemicals Known to the State to Cause Cancer" or the Reproductive Toxicity, Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65).
 2. Exterior Sealants: Sealants used on the exterior of the building - defined as from the weatherproofing system out and applied on-site - shall comply with the VOC limits of California Air Resources Board (ARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings and South Coast Air Quality management District (SCAQMD) Rule 1168 effective July 1, 2005.
- C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- E. Colors of Exposed Joint Sealants: As indicated on the Drawings or as selected by Owner from manufacturer's standard range.

2.2 SILICONE JOINT SEALANTS

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 790.
 - b. GE Momentive Performance Materials; SilPruf LM SCS2700.
 - c. Tremco Incorporated; Spectrem 1.
 2. Locations: For weathersealing exterior joints in vertical surfaces and horizontal nontraffic surfaces.
- B. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 999-A.
 - b. GE Momentive Performance Materials; Contractors SCS1000.
 - c. Pecora Corporation; 860.
 2. Locations: For general purpose sealing and bonding at exterior nontraffic applications. Do not use for structural sealant glazing, mirrors, masonry, sawn stone surfaces, lead, copper, brass, or for joints where physical abuse or abrasion is likely to be encountered.

2.3 URETHANE JOINT SEALANTS

- A. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25 or 35, for Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolastic NP1.
 - b. Pecora Corporation; Dynatrol I-XL.
 - c. Sika Corporation, Construction Products Division; Sikaflex - 1a.
 - d. Tremco Incorporated; Dymonic or Vulkem 116.
 2. Locations: For use on exterior and interior stone-to-stone and stone to adjacent materials on vertical and at horizontal nontraffic applications.
- B. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.
1. Product: Subject to compliance with requirements, provide the following:
 - a. Tremco Incorporated; Dymeric 240 FC.
 2. Locations: Weathersealing sealant for nontraffic joints in horizontal surfaces.

2.4 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Sonolac.
 - b. Pecora Corporation; AC-20+.
 - c. Tremco Incorporated; Tremflex 834.
 2. Locations: For interior vertical and overhead applications.

2.5 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; AC-20 FTR.
 - b. Tremco Incorporated; Acoustical Sealant.
 - c. USG Corporation; Sheetrock Acoustical Sealant.

2.6 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) , and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Backer Rod Mfg. Inc.; Mile High Foam.
 - b. Nomaco, Inc.; HBR.
- C. Cylindrical Sealant Backings: ASTM C 1330, Type O (open-cell material), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Backer Rod Mfg. Inc.; Denver Foam.
 - b. Nomaco, Inc.; Foam Pak II.
- D. Cylindrical Sealant Backings: ASTM C 1330, Type B (bicellular material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance. Comply with the following:
 - 1. Water Absorption: Less than 0.03 g/cc when tested in compliance with ASTM C 1016, Procedure B.
 - 2. Density: Between 1.8 and 2.5 lb/ft³ when tested in compliance with ASTM D 1622.
 - 3. Outgassing: Less than 1 bubble when tested in compliance with ASTM C 1253.
 - 4. Compression Recovery: Greater than 90 percent when tested in compliance with ASTM D 5249.
 - 5. Compression Deflection: Greater than 5 psi when tested in compliance with ASTM D 5249 using 25% compression.
 - 6. Tensile Strength: Greater than 38 psi when tested in compliance with ASTM D 1623.
 - 7. Products: Subject to compliance with requirements, provide the following:
 - a. Nomaco, Inc.; SOF Rod.
- E. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
 - 4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- G. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed and cured sealant joints as follows:

- a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
- 3.5 CLEANING
- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- 3.6 PROTECTION
- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 081113 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hollow metal doors.
 - 2. Hollow metal door frames.
- B. Related Sections include the following:
 - 1. Section 087100 "Door Hardware".
 - 2. Section 099123 "Interior Painting" for field painting factory-primed doors and frames.

1.3 DEFINITIONS

- A. Steel Sheet Thicknesses: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic-coated steel sheets.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.
- B. Shop Drawings: Show the following:
 - 1. Elevations of each door design.
 - 2. Details of doors including vertical and horizontal edge details.
 - 3. Frame details for each frame type including dimensioned profiles.
 - 4. Details and locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, accessories, joints, and connections.
 - 7. Details of moldings and removable stops.
- C. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For door inspector.
 - 1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
- B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.

- C. Field quality control reports.

1.6 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1.
- B. Hollow metal Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
 - 1. Test Pressure: Test at atmospheric pressure.
 - 2. Temperature-Rise Rating: Where indicated, provide doors that have a temperature-rise rating of 450 deg F maximum in 30 minutes of fire exposure.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
 - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hollow Metal Doors and Frames:
 - a. Ceco Door Products; a United Dominion Company.
 - b. Curries Company.
 - c. Pioneer Industries Inc.
 - d. Steelcraft; a division of Ingersoll-Rand.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.3 INTERIOR STANDARD HOLLOW METAL DOORS AND FRAMES

- A. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A. At locations indicated in the Door and Frame Schedule.
 - 1. Doors:
 - a. Type: Pairs - Flush as indicated on the drawings.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Uncoated steel sheet, minimum thickness of 0.053 inch. 16 gauge
 - d. Edge Construction: Model 1, Full Flush.
 - e. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.
 - f. STC Rating: 49, where indicate on the Drawings.
 - 2. Frames:
 - a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch. 14 gauge.
 - b. Construction: Full profile welded.
 - 3. Exposed Finish: Factory Prime.

2.4 HOLLOW METAL FRAMES

- A. Interior Frames
 - 1. Fabricate frames with mitered or coped corners.
 - 2. Fabricate frames as full profile welded unless otherwise indicated.
 - 3. Fabricate seamless fully welded frames.
 - 4. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch. 14 gauge.
 - 5. Exposed Finish: Factory Prime.
- B. Door Silencers: Except on weather-stripped frames or doors with acoustic seals, fabricate stops to receive two silencers on heads of double-door frames.
- C. Supports and Anchors: Fabricated from not less than 0.042-inch- thick, electrolytic zinc-coated or metallic-coated steel sheet.
- D. Inserts, Bolts, and Fasteners: Manufacturer's standard units.

2.5 FABRICATION

- A. General: Fabricate hollow metal door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.
- B. Clearances for Fire-Rated Doors: As required by NFPA 80.
- C. Single-Acting, Door-Edge Profile: Square edge, unless beveled edge is indicated.

- D. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
 - E. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.
 - F. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.
 - G. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.
 - H. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.
 - I. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.
 - J. Astragals: As required by NFPA 80 to provide fire ratings indicated.
- 2.6 FINISHES
- A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install hollow metal doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.
- B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 - 1. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
 - 2. In existing concrete or masonry construction, provide at least three completed opening anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices.
 - 3. In metal-stud partitions, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.
 - 4. Install fire-rated frames according to NFPA 80.
 - 5. For openings 90 inches or more in height, install an additional anchor at hinge and strike jambs.

3.2 ADJUSTING AND CLEANING

- A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.

- B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

END OF SECTION 081113

SECTION 087100 - DOOR HARDWARE

1.1 SUMMARY

- A. Section Includes:
 - 1. Hinges.
 - 2. Bored locks.
 - 3. Lock cylinders.
 - 4. Surface closers.
 - 5. Door gasketing.
- B. Related Requirements:
 - 1. Section 081113 "Hollow Metal Doors and Frames"

1.2 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Hinges.
 - 2. Cylindrical locks.
 - 3. Interchangeable core.
 - 4. Surface closers.
 - 5. Door gasketing.
 - 6. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Product Data Submittals: For each product.
- C. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of product data. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 - 2. Format: Use same scheduling sequence and format as in door hardware schedule in the Contract Documents.
 - 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.

- b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Fastenings and other installation information.
 - e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - f. Mounting locations for door hardware.
 - g. List of related door devices specified in other Sections for each door and frame.
- D. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as a Door and Hardware Specification Consultant (DHSC)

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lockup for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys and permanent cores to Owner's Representative.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures, including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
2. Warranty Period: Two years from date of Substantial Completion unless otherwise indicated below:
 - a. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of door hardware from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
 1. Air-Leakage Rate: Maximum air leakage of 0.3 cfm per sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3 inch wg (75 Pa) of water.
- B. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the "2010 ADA Standards for Accessible Design and ICC A117.1."
 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Fire-Rated Hinged Doors: 15 lbf (22.2 N) applied perpendicular to door or as allowable by authorities having jurisdiction.
 3. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
- C. Finishes shall comply with ANSI A156.18. Finishes used in hardware sets are as follows:

626	Satin Chromium Plated
630	Satin Stainless Steel
652	Satin chromium Plated
689	Aluminum powder coated or painted

2.3 HINGES

- A. Hinges: ANSI/BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
 - 1. Hager Companies
 - 2. Stanley Commercial Hardware
 - 3. McKinney Products Company; an ASSA ABLOY Group company
- B. Hinges shall be furnished in following quantities
 - 1. Door up to 90" in height: 3 hinges

2.4 MECHANICAL LOCKS AND LATCHES

- A. Bored Cylindrical lockset:
 - 1. Basis of Design: Marks USA 75 Series, 175.
- B. Lock Function: F86 Storeroom.
- C. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
- D. Lock Backset: 2-3/4 inches (70 mm) unless otherwise indicated.
- E. Lock Trim:
 - 1. Levers: Cast.
 - a. American Style lever.
 - 2. Roses: Cast, 175 American
- F. Strikes: Provide manufacturer's standard strike for each latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

2.5 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking device.
- B. Standard Lock Cylinders: ANSI/BHMA A156.5, [Grade 1] [Grade 1A] [Grade 2] permanent cores; face finished to match lockset.
 - 1. Core Type: Interchangeable.
- C. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.6 KEYING

- A. Keying System: Factory registered, complying with guidelines in ANSI/BHMA A156.28, appendix. Provide one extra key blank for each lock.
 - 1. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
- B. Keys: Nickel silver.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: Information to be furnished by Owner.

2.7 SURFACE CLOSERS

- A. Surface Closers: ANSI/BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 - 1. Basis of Design: Corbin Russwin DC6210 or DC6410,
 - 2. Parallel Arm Mounting

2.8 DOOR GASKETING

- A. Door Gasketing: ANSI/BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
 - 1. Pemko
 - 2. National Guard
- B. Maximum Air Leakage: When tested in accordance with ASTM E283/E283M with tested pressure differential of 0.3 inch wg (75 Pa), as follows:
 - 1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) of door opening.

2.9 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and ANSI/BHMA A156.18.

- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended; however, aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Fire-Rated Applications:
 - a. Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:
 - 1) Closers to doors and frames.
 - 3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 - 4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.10 FINISHES

- A. Provide finishes complying with ANSI/BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with 2010 ADA unless otherwise indicated or required to comply with Local governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (760 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Furnish permanent cores to Owner for installation.
- E. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 1. Do not notch perimeter gasketing to install other surface-applied hardware.

3.4 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.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

3.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.

- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

3.7 DOOR HARDWARE SCHEDULE

- A. Hardware Set 1: Each door to have the following:
 - (3) 4 1/2" x 4 1/2" HD FIVE KNUCKLE BUTT HINGE
 - (1) STOREROOM LOCKSET
 - (1) INTERCHANGEABLE CORE
 - (1) SILENCERS
 - (1) SURFACE MOUNTED CLOSER
 - (1) FIRE-SMOKE GASKETING

END OF SECTION 087100

SECTION 089100 - ALUMINUM LOUVERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Aluminum louvers as shown on the Drawings and as specified herein, including but not necessarily limited to the following:
 - 1. Continuous blade type, architectural vision louvers.
 - 2. Concealed snap-in support clips and accessories.
 - 3. Factory-applied finish system to louver blades.
 - 4. Field measurements and verification of all openings and all conditions of the louver installations.

1.2 RELATED SECTIONS

- A. Section 099100 - Paints and Coatings: Field applied paint finish.

1.3 REFERENCES

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- B. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- C. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- D. ASTM B 449 - Standard Specification for Chromates on Aluminum.
- E. ASTM D 1730 - Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting.
- F. ASTM D 2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
- G. ASTM D 4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

1.4 COORDINATION

- A. Coordinate Work with other operations and installation of roofing materials to avoid damage to installed insulation and membrane materials.

1.5 ACTION SUBMITTALS

- A. Submit the following in accordance with Section 013300:
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.

2. Load tables showing louver span capacities.
3. Storage and handling requirements and recommendations.
4. Installation methods.

C. Shop Drawings:

1. Layout and erection drawings showing typical cross sections and dimensioned locations of all louver blades, trees, splices and corners. Include erection drawings, elevations, and details where applicable.

D. Selection Samples:

1. For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

E. Verification Samples:

1. For each product specified, two samples, minimum 12 inches (305 mm) long, representing actual product shape and dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

B. Warranties: 3 signed copies of the following:

1. Louver Units including paint finish.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer with a minimum five years documented experience in producing architectural louver systems.

B. Provide aluminum louvers by a firm having undivided responsibility for the entire aluminum louver system design, fabrication and installation, except as otherwise specified herein.

C. Provide aluminum louvers in strict accordance with state and local building codes and ordinances and conforming to applicable wind load factors relative to framing and anchorage.

D. Pre-Installation Meeting:

1. Convene at job site, at least seven calendar days prior to scheduled beginning of construction activities of this section, to review requirements of this section.
2. Require attendance by representatives of the installing subcontractor (who will represent the system manufacturer), the mechanical subcontractors and other entities affected by construction activities of this section.
3. Notify Architect four calendar days in advance of scheduled meeting date.

E. Provide factory-applied finish aluminum system in accordance with AAMA 2605 for Superior Performance Organic Coatings on Architectural Extrusions and Panels.

1.8 DELIVERY, HANDLING AND STORAGE

- A. Deliver louver components to the project site clearly marked for proper identification.
- B. Receive, handle and store materials in conformance with the manufacturers printed instructions.
- C. Store louver components in accordance with manufacturer's instructions, above ground, in dunnage and protected from weather, construction activities and other causes of damage or loss.
- D. Handling: Use a forklift or crane to move material. Do not lift the bundles by the metal bands.
 - 1. Fork Lift: Spread the forks as far as possible to balance the load. Drive slowly when moving long bundles over uneven surfaces to avoid tipping the load
 - 2. Crane: Position the canvas sling straps so that the space between the straps is at least 1/3 the length of the bundle. Use sling straps with looped ends running one end of the strap through the loop at the other end to cinch the bundle when lifted. When setting the load on the roof, put wood blocks under it to protect the roof and allow space to remove the sling straps.
 - 3. Roof Placement: Spread the bundles and crates out as much as possible to avoid overloading the roof structure. Place the material directly over major supports such as beams or trusses.

1.9 PROJECT CONDITIONS

- A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.10 WARRANTY

- A. Louvers:
 - 1. Provide written warranty, stating that the louvers, exclusive of paint finish, will be free of faults and defects for a period of:
 - a) Products installed on projects located two miles or greater from salt or brackish bodies of water: Twenty (20) years.
 - b) Products installed on projects located greater than one mile but less than two miles from salt or brackish bodies of water will be warranted for (5) years, except for aluminum, or stainless steel products which will be warranted for (20) years.
 - c) Products installed on projects located one mile or less from salt or brackish bodies of water will be warranted for (3) years, except for aluminum, stainless steel Products which will be warranted for (20) years.

- d) Parts only orders purchased without design, engineering calculations and shop drawings provided by Seller: (2) year.
- 2. Provide warranty signed by the louver manufacturer and installing contractor.
- B. Paint Finish:
 - 1. Provide written warranty stating that the paint finish applied on all louver components will retain its film integrity, color and chalk as defined by AAMA 2605 for a period of:
 - a) Products installed on projects located 1 mile or greater from salt or brackish bodies of water: Twenty (20) years.
 - b) Products installed on projects located less than 1 mile from salt or brackish bodies of water: Three (3) years.
 - 2. Provide warranty signed by the louver manufacturer and paint finish applicator (if separate from manufacturer).
- C. The above warranties are in addition to, and not a limitation of, other rights the Owner may under the Contract Documents.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Design Loads: Comply with Building Code for site location and building height.
 - 1. Design to resist ASCE 7 - Minimum Design Loads for Buildings and Other Structures, using the latest published ASCE version.
 - 2. Design all materials, assembly and attachments to resist snow, wind, suction and uplift loading at any point without damage or permanent set.
- B. Structural Design: Prepare structural design calculations for louver assemblies including blades, clips, trees, fasteners and attachment to structure.
 - 1. Design and provide louvers to withstand a wind load of [x] psf inward and [x] psf outward with a deflection in both vertical and horizontal members not to exceed L/180.
- C. Thermal Movement: Normal thermal movement is defined as that resulting from a 120 degrees F maximum change (range) in ambient temperature. Base design calculations on actual surface temperatures of metals due to both solar heat gain and night time sky heat loss.
- D. Anchors and Connections:
 - 1. Anchors, connections and assemblies connecting the louvers and associated fabrications to the supporting construction are shown on the Drawings as suggested locations for the louver manufacturer/installer's information. The louver manufacturer/installer is responsible for the structural design and placement of the connections and anchors, including all connecting hardware, accessories and

- reinforcing necessary for fabrication, and installation of the louvers and associated fabrications.
2. The louver manufacturer is to notify the Architect in writing prior to the submittal of shop drawings of any changes in the proposed locations of connections and anchors.
3. The Architect's review of shop drawings is not to be construed as removing responsibility from the louver manufacturer/installer for structural failures related to design, fabrication, installation, and fabrication services.

2.2 MANUFACTURERS

- A. Acceptable Manufacturer: RoofScreen Mfg., which is located at: 347 Coral St. ; Santa Cruz, CA 95060; Toll Free Tel: 866-766-3727; Tel: 831-421-9230; Fax: 866-253-0738; Email: request info (info@roofscreen.com); Web: www.roofscreen.com.
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 012500, Substitutions Procedures

2.3 PRODUCTS

- A. Basis-of-Design Manufacturer and Louver: RoofScreen Mfg.
 1. VisionGuard L10 Angled Louver.

2.4 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, 6063-T6 alloy and temper.
- B. Fasteners:
 1. Provide exposed fasteners of stainless steel or carbon steel with factory applied protective coating, with finish color coating to match the finish on aluminum.
 2. Provide fasteners not exposed to view of stainless steel or carbon steel with factory applied protective coating.

2.5 FABRICATION

- A. Fabricate louvers with close-fitting, field-made splice joints in blades designed to permit expansion and contraction without deforming blades or framework and with supporting members and hardware concealed from front edges of blades so blades have continuous appearance.
- B. General:
 1. Fabricate all units to produce uniform sight lines and to be level, plumb and in same plane as adjacent panels.
 2. Accurately fabricate all joints for proper fit.
 3. Protect exposed surfaces against damage from scratches and discoloration.
- C. Louvers:

1. Fabricate continuous blade louvers from minimum 0.1 inch thick extruded aluminum to shapes and configurations shown on the Drawings.
 2. Provide support clips from minimum 0.125 inch thick extruded aluminum to comply with specified performance criteria and manufacturer's fabrication procedures and standards.
 3. Provide vertical supports ("trees") from minimum 3 inch by 3 inch by 0.188 inch thick extruded aluminum angles to comply with specified performance criteria and manufacturer's fabrication procedures and standards, at spacings not further apart than recommended by manufacturer.
 4. Corners:
 - a. Provide inside and outside corners fabricated from 6 inch by 6 inch by 0.100 inch thick aluminum trim, painted to match louver blades, to be fastened with exposed fasteners.
 - b. Provide inside and outside mitered louver blades 24 inches in length to be installed butted together in field to form louver corners.
 - c. Provide inside and outside corners fabricated from mitered and welded louver blades that extend 24 inches in each direction. Finish corners after welding is complete.
- D. Provide all accessories and materials for fabrication, assembly and installation required to provide a complete and warranted louver installation.

2.6 FINISH OF ALUMINUM

- A. Provide all louver members and accessories free of scratches and serious blemishes affecting the finish system.
- B. Fluoropolymer Paint Finish: Factory finish all louver members, trims and mitered corners with thermoset fluoropolymer paint system in accordance with the manufacturer's printed requirements and performance specifications and the AAMA specification Ref. AAMA 2605 for Superior Performance Organic Coatings on Aluminum Extrusions and Panels.
- C. Color selection will be made by the Architect from manufacturer's standard colors.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine all surfaces to receive parts of the work specified herein. Verify all dimensions of in-place and subsequent construction. Installation of louvers constitutes acceptance of the existing conditions.

3.2 INSTALLATION

- A. Set all items in their correct locations as shown on the final reviewed shop drawings, level, square, plumb and at proper elevations and in alignment with other work.
- B. Assemble and anchor the various components to allow for expansion and contraction, maintaining a watertight installation.

3.3 CLEANING & PROTECTION

- A. After erection, protect exposed portions of the louvers from damage.
- B. Just prior to final acceptance, remove protective coverings and clean surfaces with plain water or if required, with a solution as recommended by manufacturer of finish coating system.
- C. Touch up finish coat system of all imperfections as recommended by manufacturer of finish coating system.
- D. Remove and replace any component that cannot be successfully repaired at no additional cost to the Owner.

END OF SECTION 089100

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
 - 2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.
- B. Related Sections:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for fasteners for attaching wall-mounted accessories to gypsum wall construction.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including documentation of recycled content.
- B. Shop Drawings: Dimensioned drawings, including plans, elevations, and sections showing materials, spacing, sizes, thicknesses, profiles, and finishes.
 - 1. Label individual components and indicated material gages, design loads, required clearances, and methods of field installation.
 - 2. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, and accessories.
 - 3. Identify welds by AWS welding symbols.
 - 4. Distinguish between factory-and field-assembled Work.
 - 5. Submit project-specific, minimum 1-1/2-inch scale dimensioned details showing connection details and attachments to other Work, including holes, fasteners, and inserts.
 - 6. Furnish 3-dimensional or isometric drawings for conditions too difficult to illustrate in 2-dimensional drawings.
- C. Design Data: For fabrications and assemblies specified to comply with design loads, submit fabricator's engineering analysis data.

1.4 INFORMATION SUBMITTALS

- A. Evaluation Reports: For firestop tracks, from ICC-ES.
- B. Test reports: From the National Evaluation Service (NES) or International Code Council Evaluation Services (ICC-ES), or equivalent report from qualified testing agency acceptable to authorities having jurisdiction, evidencing compliance with building code requirements and specified performance requirements for the following:
 - 1. Steel sheet.
 - 2. Vertical deflection and horizontal drift connectors.

- 3. Bridging.
- 4. Miscellaneous structural clips and accessories.
- C. Mill Certificates: Certifying that material furnished complies with specified requirements.
- D. Welder's Certificates: Copies of current welder's certificates.
- E. Qualification Statements: Description of Installer's experience.

1.5 QUALITY ASSURANCE

- A. Installer's Qualification: Firm and individuals with a minimum of 5 consecutive years' experience in the installation of specified products, and whose installation has resulted in applications with a record of successful in-service performance on projects similar to this Project in material, design, complexity, and extent.
- B. Welder's Qualifications: Qualify welding procedures and personnel in compliance with American Welding Society (AWS) qualification requirements of AWS D1.1 and AWS D 1.3.
 - 1. Verify welders to be employed in the Work have satisfactorily passed AWS qualification tests and are current in their certification.
 - 2. If re-certification is required, re-testing shall be Contractor's responsibility.
- C. Reference Standards: Comply with ASTM C 754 requirements for installation of non-structural metal framing, except comply with framing sizes and spacing indicated. Comply with the following:
 - 1. ASTM C 840 for framing installation.
 - 2. ASTM C 844 requirements for framing installation in gypsum veneer plaster assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.
- C. Remove corroded, deteriorated, stained, or damaged materials from the site and replace at no cost to Owner.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ClarkDietrich Building Systems.
 - 2. Marino\WARE.
 - 3. The Steel Network, Inc.
 - 4. United States Gypsum Co.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized, unless otherwise indicated.
- D. Studs and Runners: ASTM C 645.
 - 1. Steel Studs and Runners:
 - a. Minimum Base-Metal Thickness: 0.033 inch (20 gage).
 - b. Depth: As indicated on Drawings .
- E. Slip-Type Head Joints: Where indicated, provide the following:
 - 1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) ClarkDietrich Metal Framing; SLP-TRK Slotted Deflection Track.
 - 2) MBA Building Supplies; FlatSteel Deflection Track or Slotted Deflecto Track.
 - 3) Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
- F. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fire Trak Corp.; Fire Trak System.
 - b. Grace Construction Products; FlameSafe FlowTrak System.
 - c. Metal-Lite, Inc.; The System.
- G. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base-Metal Thickness: 0.053 inch (16 gage).
- H. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness (16 gage), with minimum 1/2-inch- wide flanges.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- I. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 0.033 inch (20 gage).
 - 2. Depth: 7/8 inch.
- J. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical.

- K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter (16 gage) wire.
- B. Hanger Attachments to Concrete:
 1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter (8 gage).
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (16 gage) and minimum 1/2-inch- wide flanges.
 1. Depth: 1-1/2 inches.
- E. Furring Channels (Furring Members):
 1. Cold-Rolled Channels: 0.1046-inch (12 gage) uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
 2. Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.033 inch (20 gage).
 - b. Depth: As indicated on Drawings.
 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base-Metal Thickness: 0.033 inch (20 gage).
 4. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical.
- F. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World industries, inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Drywall Grid System.
 - c. USG Corporation; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Floor Anchors For Partial-Height Walls: Pinquist Tool & Die Co., Inc.; Floor Anchor, or approved equal at each stud.
- C. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
 1. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 2. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and backing plates to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details on Drawings, with recommendations of steel stud manufacturer, and with USG Corporation's "Gypsum Construction Handbook." Wall-mounted items requiring supplementary backing plates include, but are not limited to the following:
 1. Grab bars.
 2. Baby-changing stations.
 3. Toilet compartments and screens.
 4. Toilet room and shower accessories.
 5. Wall and base cabinets.

6. Wall standards for shelving.
 7. Plumbing fixtures.
 8. Ladders.
 9. Elevator screens.
 10. Wall-mounted door stops.
 11. Handrails, crash rails, chair rails, and similar wall protection.
 12. Television and monitor brackets.
 13. Marker boards and tack boards.
 14. Artwork.
 15. Wall-mounted writing and computer stations.
- C. Backing plates may be omitted if anchorage for wall-mounted items is directly to steel sheet of minimum 0.043-inch (18 gage) base metal thickness, or if items are furnished with equivalent mounting devices.
- D. Wall-mounted items with a length long enough to span a minimum of 3 studs and without provided backing plates, shall be mounted to one of the following, unless otherwise indicated:
1. Minimum 4-inch-wide coated steel sheet with a minimum base metal thickness of 0.053 inches (16 gage). Weld plates continuously along all contact surfaces at each stud crossing, or secure with 2 countersunk machine screws at each stud.
 2. Minimum 4-inch-wide coated steel un-punched wide-flange stud with a minimum base metal thickness of 0.053 inches (16 gage). Notch studs so backing plate will be flush with exterior face of studs.
- E. Install bracing at terminations in assemblies.
- F. Welding: Where systems are indicated to be welded, perform welding in compliance with AWS recommendations.
1. Welders shall be qualified to weld light-gage metal.
 2. Provide stitch plates where studs are burned through.
- G. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Layout partitions and permanently mark locations on surface of floor deck.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Locate studs a minimum of 2 inches away from concrete or masonry walls, steel columns, or other superstructure items. Extend the horizontal stiffeners and attach to superstructure.
- D. Install studs so flanges within framing system point in same direction.
1. Space studs as follows:
 - a. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - b. Multilayer Application: 16 inches o.c. unless otherwise indicated.
 - c. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- E. Install tracks (runners) at floors and overhead supports.
1. Space anchors within 6 inches of ends of each track segment and at a maximum of 24 inches o.c.
 2. Do not install fasteners within 3 inches of slab or curb edge.

- F. Extend framing full height to structural supports or substrates above.
1. Install studs in single lengths extending from floor to underside of floor or roof structure above without joints, except where indicated on Drawings to stop at or above suspended ceilings. Do not splice studs without prior approval of Owner.
 2. Assemble corners using a minimum of 3 studs.
 3. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 4. Attach studs to tracks by friction fit for single stud gypsum board partitions. At the following locations, attach studs to floor tracks with screws or with crimping tool, in compliance with stud manufacturer's instructions, except where studs are indicated to be welded.
 - a. Studs with gypsum board on one side only.
 - b. Studs on each side of doors and windows.
 - c. Studs supporting wall-hung plumbing fixtures.
 - d. Studs supporting wall-hung urinal screens, toilet compartments, cabinets, and equipment.
 5. Continue framing around ducts penetrating partitions above ceiling.
 6. Where studs stop at or above suspended ceilings, brace with opposite stud bracing at 45 deg angle and securely anchor to underside of floor or roof assembly above, at a maximum spacing of every fourth stud, unless otherwise indicated.
 7. Provide horizontal bridging at 54 inches o.c. maximum in all partitions supporting wall-hung cabinets, unless otherwise indicated.
 - a. Provide an additional 3/4-inch channel 6 inches above door head and extend a minimum of 2 stud spaces beyond jamb studs.
 - b. Install channels in longest possible lengths.
 - c. At end joints, lap channels a minimum of 12 inches and wire-tie.
- G. Do not tie together channels on opposite sides of staggered-stud or double-stud partitions.
- H. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
1. Install two studs at each jamb unless otherwise indicated.
 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 3. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
- I. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
1. Provide additional framing as required for installation of electrical devices, fire extinguisher cabinets, and similar items recessed into stud walls.
- J. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
- K. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- L. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- M. Curved Partitions:
- N. Cut top and bottom runners through leg and web at 2-inch intervals for arc length. Allow for uncut straight lengths of not less than 12 inches at ends of arcs.

- O. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
- P. Support outside (cut) leg of tracks by clinching a 1-inch high, 0.027-inch thick (22 gage) steel sheet strip to inside of cut legs using metal lock fasteners.
- Q. Where curved partitions are indicated to stop at suspended ceilings, attach tracks to suspended ceilings with toggle bolts or hollow wall anchors located 2 inches from ends and spaced 16 inches o.c.
- R. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c., with last stud left free-standing.
- S. Attach studs to runners with 3/8-inch-long pan head framing screws.
- T. Z-Furring Members:
- U. Erect insulation (specified in Section 07 21 00 "Thermal Insulation" vertically and hold in place with Z-furring members spaced 24 inches o.c.
- V. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- W. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- X. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
 - a. Install hangers to maintain a minimum of 2 inches between hangers and ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
- 3.6 PROTECTION
- A. Repair damaged galvanized coatings with galvanizing repair paint specified in Section 05 50 00 "Metal Fabrications," in compliance with method specified in ASTM A 780, Annex A2.
- B. Protect installed framing during the construction period in a manner that will ensure materials are without damage, corrosion, or deterioration at time of Substantial Completion.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
- B. Related Sections:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for fasteners for attaching wall-mounted accessories to gypsum wall construction.
 - 2. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations, fabrication, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Signed by manufacturers of gypsum board products certifying that their products comply with specified requirements.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Gypsum Board Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.
- B. Source Limitations for Gypsum Board Accessories and Finishing Materials: Obtain accessories and finishing materials from either the same manufacturer that supplies gypsum board or other panel products or from a manufacturer acceptable to gypsum board manufacturer.
- C. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Install mockups for the following:

- a. Each level of gypsum board finish indicated for use in exposed locations.
 2. Apply or install final decoration indicated, including painting and wall coverings, on exposed surfaces for review of mockups.
 3. Simulate finished lighting conditions for review of mockups.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 1.6 DELIVERY, STORAGE AND HANDLING
- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
 - B. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.
- 1.7 FIELD CONDITIONS
- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
 - B. For non-adhesive attachment of gypsum board to framing, maintain not less than 40 deg F. For adhesive attachment and finishing of gypsum board, maintain not less than 50 deg F for 48 hours before application and continuously after until dry. Do not exceed 95 deg F when using temporary heat sources.
 - C. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
 - D. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.
 - E. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. Fire-Resistance Ratings: As indicated by design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspection agency acceptable to authorities having jurisdiction.

- C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

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

- 1. Georgia-Pacific Gypsum LLC.
- 2. National Gypsum Company.
- 3. USG Corporation.

- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

- 1. Thickness: 5/8 inch.
- 2. Long Edges: Tapered.
- 3. Products:

- a. Georgia-Pacific Gypsum LLC; ToughRock FireShield.
- b. National Gypsum Company; Gold Bond Fire-Shield.
- c. USG Corporation; Sheetrock FireCode.

- C. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core.

- 1. Core: 5/8 inch, Type X.
- 2. Long Edges: Tapered.
- 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- 4. Products:

- a. Georgia-Pacific Gypsum, LLC; DensArmor Plus Fireguard.
- b. USG Corporation; Fiberock Aqua-Tough.

- D. Impact-Resistant and Abuse-Resistant Gypsum Board: ASTM C 1658/C 1658M.

- 1. Core: 5/8 inch, Type X.
- 2. Long Edges: Tapered.
- 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- 4. Products:

- a. Georgia-Pacific Gypsum, LLC; Dens-Armor Plus Impact-Resistant.
- b. USG Corporation; Fiberock VHI Abuse-Resistant.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - e. Expansion (Control) Joint: Provide one of the following products or approved equal:
 - 1) Phillips Manufacturing Co.; E-Z Strip.
 - 2) United States Gypsum Corp.; No. 093.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, provide one of the following.
 - a. Use setting-type compound for installing paper-faced metal trim accessories
 - b. For wet areas where joint is subject to moisture and high humidity, provide sandable, setting-type chemically-hardening compound recommended or approved by gypsum panel manufacturer.
 - c. For other areas, provide drying type, all-purpose compound recommended or approved by gypsum manufacturer.
 3. Fill Coat: For second coat, provide one of the following:
 - a. For wet areas where joint is subject to moisture and high humidity, provide sandable, setting-type chemically-hardening compound recommended or approved by gypsum panel manufacturer.
 - b. For other areas, provide drying type, all-purpose compound recommended or approved by gypsum manufacturer.
 4. Finish Coat: For third coat, provide one of the following:
 - a. For wet areas where joint is subject to moisture and high humidity, provide sandable, setting-type chemically-hardening compound recommended or approved by gypsum panel manufacturer.
 - b. For other areas, provide drying type, all-purpose compound recommended or approved by gypsum manufacturer.
 5. Skim Coat: For final coat of Level 5 finish, provide one of the following:

- a. For wet areas where joint is subject to moisture and high humidity, provide sandable, setting-type chemically-hardening compound recommended or approved by gypsum panel manufacturer.
- b. For other areas, provide drying type, all-purpose compound recommended or approved by gypsum manufacturer.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 1. Low-Emitting Materials: Where possible, all adhesives used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following requirements as applicable to the Project scope:
 - a. Adhesives must comply with South Coast Air quality Management District (SCAQMD) Rule #1168. Volatile organic compound (VOC) limits listed in the table below correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.
 - b. Aerosol adhesives must comply with Green Seal standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.
 - c. Adhesives shall contain no carcinogen or reproductive toxicant components present at more than 1% of total mass of the product as defined in the California Office of Environmental Health Hazard Assessment's (OEHHA) list entitled "Chemicals Known to the State to Cause Cancer" or the Reproductive Toxicity, Safe Drinking Water and toxic Enforcement Act of 1986 (Proposition 65).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 1. Provide minimum No. 8 (0.1640-inch UTS shaft diameter) bugle head carbon steel screws having a corrosion-resistant electrodeposited zinc coating complying with ASTM B 633, minimum thickness class Fe/Zn 8, Type IV; carbon steel screws having baked-on organic-polymer coating; or austenitic stainless-steel screws complying with ASTM A 276, Type 304; threads and length as recommended by panel manufacturer.
 2. Use self-drilling tapping screws complying with ASTM C 954 for fastening panels to steel members from 0.033 inch (20 gage) to 0.112 inch (12 gage) thick.
 3. Use self-piercing tapping screws complying with ASTM C 1002, Type S for fastening panels to steel members 0.027 inch (22 gage) thick, or thinner.
 4. Use self-piercing tapping screws complying with ASTM C 1002, Type G for fastening gypsum board to gypsum board.
 5. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
 2. Low-Emitting Materials: Batt insulation products shall contain no added formaldehyde, including urea formaldehyde, phenol formaldehyde, and urea-extended phenol formaldehyde.

- E. Acoustical Joint Sealant: As specified in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels' not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
 - 4. Provide 1/2 inch gap between the bottom of gypsum board and top of floor slab, fill gap with continuous sealant. Provide fire rated sealant for rated partitions.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: All surfaces unless indicated otherwise.
 - 2. Moisture- and Mold-Resistant Type: As indicated on Drawings.
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 - 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
 - a. Space fasteners in gypsum panels according to manufacturer's recommendations and to requirements of referenced fire-rated assemblies.
 - 1) Space screws a maximum of 12 inches o.c. for vertical applications.

3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Owner for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. LC-Bead: Use at exposed panel edges where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
 - 3. L-Bead: Use where edge trim can only be installed after gypsum panels are installed.
 - 4. U-Bead: Use at exposed panel edges where indicated.

- D. Aluminum Trim: Install in locations indicated on Drawings.

3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
1. Level 1: Ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 2. Level 2: Panels that are substrate for tile and where indicated on Drawings.
 3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 4. Level 5: At panel surfaces in the following areas:
 - a. Walls and soffits in all rooms with a dimension longer than 30 feet.
 - b. Walls and soffits perpendicular to and intersecting with exterior windows.
 - c. Walls and soffits scheduled to receive semi-gloss paint finish.
 - d. Walls and soffits subject to harsh direct lighting (wall washers), as indicated on Drawings.
 - e. Other walls and soffits where indicated on Drawings.
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.6 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Owner will conduct an above-ceiling observation prior to installation of gypsum board ceilings and report any deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
1. Notify Owner one week in advance of the date and time when the Project, or part of the Project, is ready for an above-ceiling observation.
 2. Prior to notifying Owner, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control air tubing.
 - f. Installation of ceiling support framing.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Acoustical panels and exposed suspension systems for ceilings.
- B. Related Sections:
 - 1. Section 07 92 00 "Joint Sealants" for acoustical sealant.
- C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including documentation of recycled content.
- B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to a minimum scale of 1/4 inch per foot, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
 - 1. Ceiling suspension system members.
 - 2. Method of attaching hangers to building structure.
 - 3. Layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Size and location of initial access modules for acoustical panels.
 - 6. Perimeter moldings.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes 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. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed, unless limited by Owner's storage capabilities.
 - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed, unless limited by Owner's storage capabilities.
 - 3. Hold-Down Clips: Equal to 2 percent of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Where indicated, acoustical ceiling shall withstand the effects of earthquake motions determined according to CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings – Seismic Zones 0-2."
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 450 or less.

- C. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Low-Emitting Materials: Ceiling panels shall comply with the testing and product requirements of the California Department of Health Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.1 (CDPH/EHLB Standard Method V1.1) modeled using the standard office building protocol parameters and certified as compliant by an independent third party.
- B. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.
- C. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

2.3 ACOUSTICAL PANELS ACT-1

- A. Manufacturers: Subject to compliance with requirements, provide ceiling panel and/or grid components to match existing ceiling system or by one of the following manufacturers:
 - 1. Armstrong World Industries
 - 2. USG
- B. Color: White.
- C. LR: Not less than 0.86.
- D. NRC: Not less than 0.70.
- E. CAC: Not less than 35.
- F. Edge/Joint Detail: Square.
- G. Thickness: 3/4 inch.
- H. Modular Size: 24 by 24 inches.

- I. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- J. Location: As indicated on Drawings.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements where indicated.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Post-installed expansion anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - c. Corrosion Protection: For use with aluminum suspension system, stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
 - 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Stainless-Steel Wire: For use with aluminum suspension system, ASTM A 580/A 580M, Type 304, nonmagnetic.
 - 3. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.
- E. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces where required.
- F. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces where required.

- G. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place where required.
- H. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.
- I. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including manufacturer's standard antimicrobial gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.5 METAL SUSPENSION SYSTEM MSS-1

- A. Manufacturers: Subject to compliance with requirements, provide Armstrong World Industries, Prelude XL, or USG Donn DX 15/16", or approved equal.
- B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 15/16-inch-wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Runners: Butt-edge type.
 - 3. Face Design: Flat, flush.
 - 4. Cap Material: Steel cold-rolled sheet.
 - 5. Cap Finish: Painted white.
- C. Locations: All areas, unless noted otherwise.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Subject to compliance with requirements, provide Armstrong World Industries; Axiom Classic Trim, or USG Compasso Elite Edge Trim, or approved equal.
- B. Extruded-Aluminum Edge Moldings and Trim: At curved ceiling sections, and where indicated, provide manufacturer's extruded-aluminum edge moldings and trim indicated, 6-inch or 12-inch units as indicated, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements (where required) and the following:
 - 1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
 - 2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordination: Furnish layouts for cast-in-place anchors, clips, and other ceiling anchors whose installation is specified in other Sections.
 - 1. Furnish cast-in-place anchors and similar devices to other trades for installation will in advance of time needed for coordinating other work.
- B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M, and seismic design requirements indicated, according to manufacturer's written instructions and Cisca's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacing's that interfere with location of hangers at spacing's required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

7. Do not attach hangers to steel deck tabs.
 8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 9. Space hangers not more than 48 inches O.C. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 11. All items not part of the suspended ceiling system shall be individually supported to the structure above. Utilize support such as furring strips with spacers as necessary to support any non-ceiling system items to not interfere with ceiling panel placement.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches O.C. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. Arrange directionally patterned acoustical panels as follows:
 - a. Install panels with pattern running in one direction parallel to short axis of space.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 5. Install hold-down and impact clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
 6. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Resilient base.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of product indicated.
- C. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.
- D. Product Schedule: For resilient products. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.6 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed

PART 2 - PRODUCTS

2.1 RESILIENT BASE

- A. Resilient Base:
 - 1. Manufacturers: Basis of Design as scheduled on the drawings or equal product by one of the following:
 - a. Armstrong World Industries, Inc.
 - b. Flexco, Inc.
 - c. Johnsonite.
- B. Resilient Base Standard: ASTM F 1861.
 - 1. Material Requirement: Type TV (vinyl, thermoplastic).
 - 2. Manufacturing Method: Group I (solid, homogeneous).
 - 3. Style: Cove (base with toe).
- C. Minimum Thickness: 0.125 inch.
- D. Heights:
 - 1. 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Preformed.
- G. Inside Corners: Preformed.
- H. Finish: Matte.
- I. Colors and Patterns: To match existing base both sides. Submit samples to Architect from full range of industry colors.
- J. INSTALLATION MATERIALS
- K. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- L. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
 - 1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Cove Base Adhesives: Not more than 50 g/L.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are same temperature as the space where they are to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
- B. Perform the following operations immediately after completing resilient product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Damp-mop surfaces to remove marks and soil.

Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096513

SECTION 099113 - EXTERIOR PAINTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Steel and iron.
- B. Related Requirements:
 - 1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.

3. Label each coat of each Sample.
 4. Label each Sample for location and application area.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.

- a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
- b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

- a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Benjamin Moore & Co.
 2. Coronado Paint; Insl-X Products Corporation; a Benjamin Moore company.
 3. McCormick Paints.
 4. PPG Architectural Finishes, Inc.
 5. Sherwin-Williams; Paint Stores Group.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.
- D. Colors: As selected by Architect from manufacturer's full range or as indicated in a color schedule.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Paint entire exposed surface of window frames and sashes.
 - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed to view:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe supports.

- d. Metal conduit.
- e. Plastic conduit.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR AND INTERIOR UNCOATED STEEL COATINGS

- A. Description: Field-applied, anti-corrosion, high-performance coating system applied to exterior and interior shop-primed uncoated ferrous metal surfaces.
- B. Material Compatibility:
 - 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
- C. Low-Emitting Materials:
 - 1. Exterior: Coatings used on the exterior of the building - defined as from the weatherproofing system out and applied on-site - shall comply with the VOC limits of California Air Resources Board (ARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings and South Coast Air Quality Management District (SCAQMD) Rule 1168 effective July 1, 2005.
- D. Colors: As indicated on Drawings or as selected by Owner from manufacturer's standard range.

3.6 GALVANIZED STEEL COATINGS

- A. Description: Field-applied, anti-corrosion, high-performance coating system applied to exterior and interior unprimed zinc-coated ferrous metal surfaces.
- B. Material Compatibility:
 - 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.

C. Low-Emitting Materials:

1. Exterior: Coatings used on the exterior of the building - defined as from the weatherproofing system out and applied on-site - shall comply with the VOC limits of California Air Resources Board (ARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings and South Coast Air Quality Management District (SCAQMD) Rule 1168 effective July 1, 2005.

D. Colors: As indicated on Drawings or as selected by Owner from manufacturer's standard range.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

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. This Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Interior ferrous metal.
 - 2. Interior gypsum board.
 - 3. Concrete masonry unit
- B. Extent of painting is indicated on Drawings and in schedules, and as herein specified.
- C. Work includes painting and finishing of interior exposed items and surfaces throughout the Project, except as otherwise indicated.
 - 1. Surface preparation, priming and costs of paint specified are in addition to shop-priming and surface treatment specified under other Sections.
- D. Work includes painting of hollow metal door frames.
- E. Paint exposed surfaces, except where the paint schedule specifically indicates that a surface or material is not to be painted or is to remain natural. The Finish Schedule, when provided with other Contract Documents, indicates walls to be finished by their cardinal points (north, east, south, and west) in relation to the overall room. The wall finish(es) indicated for the referenced wall are to be considered applicable to the entire wall, corner to corner, regardless of how that wall is configured. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors.
- F. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels. Refer to Contract Drawings and schedules for extent of painted surfaces.
 - 1. Prefinished items not to be painted include the following factory-finished components:
 - a. Architectural woodwork and casework.
 - b. Finished mechanical and electrical equipment.
 - 2. Light fixtures. Concealed surfaces not to be painted include walls or ceilings in the following generally inaccessible spaces:
 - a. Ceiling plenums.
 - 3. Finished metal surfaces not to be painted include the following:
 - a. Anodized aluminum,
 - b. Stainless steel.
 - c. Chromium plate. Copper.
 - d. Bronze.
 - e. Brass.
 - f. Similar finished metals

4. Operating parts not to be painted include moving parts of operating equipment and the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sinkages.
 - d. Sensing devices.
 - e. Motors and fan shafts.
 - f. Similar parts.
 5. Other surfaces not to be painted unless specifically indicated in the Drawings:
 - a. Steel decking (unless otherwise indicated).
 - b. Insulation and its facing.
 - c. Sprayed fireproofing.
 - d. Finish hardware, except those items noted USP.
 - e. Operating parts, labels and nameplates.
 6. Labels: Do not paint over Underwriter's Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- G. Related Sections include the following:
1. Division 08 Sections for shop priming of steel frames.
- 1.3 DEFINITIONS –
- A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
1. "Flat" refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 2. "Eggshell" refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.
 3. "Satin" refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
 4. "Semi-Gloss" refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
 5. "High Gloss" refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.
- 1.4 ACTION SUBMITTALS
- A. General: Submit the following according to the conditions of the Contract:
1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis, material safety data sheets, and instructions for handling, storing, and applying each coating material proposed for use.
 3. Certification by the manufacturer that products supplied comply with local regulations **(OTC)** controlling use of volatile organic compounds (VOCs).
- B. Product Data: For each paint system specified.

- C. Samples for Verification: Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of actual substrate.
 - 1. Provide a list of materials and applications for each coat of each sample. Label each Sample for location and application.
- 1.5 INFORMATIONAL SUBMITTALS
 - A. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience, submittal to include lists of completed projects with project names and addresses. Names and addresses of architects and owners, and other information specified.
- 1.6 QUALITY ASSURANCE
 - A. MPI Standards:
 - 1. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.
 - B. Ozone Transportation Commission: All products supplied under this specification section for the locations listed below must be compliant with the VOC limits established in the Clean Air Act Amendments of 1990.
 - C. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
 - D. Source Limitations: Obtain primers, and undercoat materials for each coating system from the same manufacturer as the finish coats. Use only thinners approved by paint manufacturer, and only within recommended limits.
- 1.7 COORDINATION
 - A. Coordination of Work: Review other Sections of these Specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.
- 1.8 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver materials to the Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Manufacturer's stock number and date of manufacturer.
 - 4. Contents by volume, for pigment and vehicle constituents.
 - 5. Thinning instructions.
 - 6. Application instructions.
 - 7. Color name and number.
 - 8. VOC content.
 - B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 - 1. Protect from freezing.
 - 2. Keep storage area neat and orderly.

3. Remove-rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.9 PROJECT CONDITIONS

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F.
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F.
- C. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
 1. Painting may continue during inclement weather if surfaces to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.10 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and with labels describing contents. Deliver extra materials to the Owner.
 1. Quantity: Furnish the Owner with an additional **5 percent**, but not less than 1 gallon or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Sherwin-Williams Company (The).
 2. Benjamin Moore & Co.
 3. PPG Architectural Coatings
 4. Or approved equal.
- B. **Products:** Subject to compliance with requirements, provide products indicated in the "Interior Painting Schedule" article in part 3 of this Section. The paint systems identified herein identify products of one or more, but not necessarily all of the above-named manufacturers. For each paint system, provide the products of a single manufacturer for all primers and finish coats within an individual system.

2.2 PAINT, GENERAL

- A. Material Compatibility:
 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Material Quality: Provide manufacturer's best quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- C. VOC Content of Field Applied Interior Paints and Coatings: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the

following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- D. VOC Content of Field-Applied Anti-Corrosive and Anti-Rust Paints: Provide products that do not exceed 250 grams per liter, less water, as established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.
- E. VOC Content of Field-Applied Wood Finishes: Provide products for Clear wood finishes, floor coatings, stains, primers and shellacs that comply with the VOC content limits established in South Coast Air Quality Management District Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.
- F. Colors: Provide color selections made by the Owner, or as indicated in the project finish schedule.

2.3 BLOCK FILLERS.

- A. Interior/Exterior Latex Block Filler: MPI #4.

2.4 PRIMERS / SEALERS

- A. Interior Latex Primer/Sealer: MPI #50.

2.5 METAL PRIMERS

- A. Alkyd Anticorrosive Metal Primer: MPI #79.
- B. Rust-Inhibitive Primer (Water Based): MPI #107.
- C. Waterborne Galvanized-Metal Primer: MPI #134.
- D. Vinyl Wash Primer: MPI #80.
- E. Quick-Drying Primer for Aluminum: MPI #95.
- F. Interior Latex-Based Wood Primer: MPI #39.

2.6 LATEX PAINTS

- A. Must meet the MPI requirements stated below or alternatively be GS 11 compliant for VOC content, or be certified by the manufacturer as meeting or exceeding the VOC requirement of GS 11.
- B. Institutional Low-Odor/VOC Latex (Flat): MPI #143 (Gloss Level 1).
- C. Institutional Low-Odor/VOC Latex (Low Sheen): MPI #141 (Gloss Level 5).
- D. Low-Odor/VOC Latex (Eggshell): MPI #52 (Gloss Level 3).
- E. Low-Odor/VOC Latex (Semi-Gloss): MPI #54 (Gloss Level 5).

Acrylic Enamel (Semi-Gloss): MPI #81 (Gloss Level 5).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
 - 1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
 2. Masonry (Clay and CMU): 12 percent.
 - a. Allow masonry to cure a minimum of 28 days prior to paint application regardless of moisture content.
 3. Wood: 15 percent.
 4. Gypsum Board: 12 percent.
- C. Applicator must notify Contractor in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Applicator.
- D. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.
- E. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
1. Notify the Owner about anticipated problems using the materials specified over substrates primed by others.
 2. Application of any paint product not meeting the low or Zero VOC requirements of this specification may not be field applied on Hospital property without the express approval of the owner, and is subject to additional protective environmental measures before such permission may be granted.
- 3.2 PREPARATION
- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations in each space or area, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- C. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair the bond of the various coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Schedule cleaning and painting so dust and other contaminants for the cleaning process will not fall on wet, newly painted surfaces.
 2. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition as specified.
1. Provide barrier coats over incompatible primers or remove and re-prime. Notify Owner in writing about anticipated problems using the specified finish - coat material with substrates provided by others.
 2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and

mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

- a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
 - b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.
- E. Aluminum Substrates: Remove loose surface oxidation.
- F. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, rust, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
1. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
- G. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- H. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
1. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
 2. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases, and paneling.
 3. When transparent finish is required, back-prime with spar varnish.
 4. Back-prime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.
 5. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
- I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth. Exercise care to avoid raising nap of paper.
- J. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.
- K. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

- A. General: Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques best suited for substrate and type of material being applied.
- B. Do not begin painting until permanent room lighting is in place and operating, or utilize temporary lighting of a type and quantity to approximate ambient room light upon completion, as approved by the Owner. Apply paint in accordance with manufacturer's directions.
 - 1. Paint colors, surface treatments, and finishes are indicated in the Drawings and schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. The term "exposed surfaces" includes areas visible when permanent or in-built fixtures, conveyor covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 - 5. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 6. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers and grilles.
 - 7. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match adjacent exposed surfaces.
 - 8. Paint interior door frames as scheduled on the drawings.
 - 9. Sand lightly between each succeeding enamel or varnish coat.
- C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - 2. Omit primer on metal surfaces that have been shop primed and touchup painted.
 - 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 - 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion. In areas where paintable silicone sealant is used, apply prime coat to sealant within 48 hours of application.
- D. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
 - 1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
 - 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by

the manufacturer for the material and texture required.

3. Spray Equipment: Spray painting is not permitted except by prior approval of the Owner.
 - E. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
 - F. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.
 1. All sprinkler and medical gas piping exposed and concealed in accessible areas (chases, ceiling spaces, etc.) is to be painted as per "Pipe and Equipment Identification Schedule" paragraph in "Interior Painting Schedule" article below.
 - G. Mechanical items to be painted include, but are not limited to, the following:
 1. Piping, pipe hangers, and supports.
 2. Accessory items.
 - H. Electrical items to be painted include, but are not limited to, the following:
 1. Conduit and fittings.
 - I. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
 - J. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
 - K. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
 - L. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
 1. Provide satin finish for final coats.
 - M. Stipple Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
 - N. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- 3.4 FIELD QUALITY CONTROL
- 3.5 CLEANING
- A. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 - B. After completing paint application, clean glass and paint-spattered surfaces. Remove spattered paint by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- 3.6 PROTECTION
- A. Protect work of other trades, whether being painted or not, against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as

approved by Owner, and leave in an undamaged condition.

- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1. Roller painted surfaces are to be touched up with a roller, and brush painted surfaces are to be touched up with a brush.

3.7 INTERIOR PAINTING SCHEDULE

- A. General: Provide the following paint systems for the various substrates, as indicated; unless noted otherwise in the Construction Documents.
- B. Paint System No. 1:
 - 1. Surface: Interior ferrous metal.
 - 2. Thickness: Not less than 2.5 mils.
 - 3. Gloss: Semi-gloss.
 - 4. Primer: Interior/Exterior Rust Inhibitive Primer S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 series, Benjamin Moore; Insul-x Corotech Acrylic Metal Primer V-110, . PPG 90-912 Pitt-Tech® Plus Int./Ext. DTM Industrial Primer
 - 5. 2nd Coat: Interior/Exterior Acrylic Semi-Gloss Enamel S-W Pro Industrial Zero VOC Acrylic Semi-Gloss, B66-650 series, Benjamin Moore; Coronado Rust scat Acrylic Semi-Gloss 90 Line, PPG 90-1210 series Pitt-Tech Plus Int./Ext. Semi-Gloss DTM Industrial Enamel
 - 6. Finish Coat: Interior/Exterior Acrylic Semi-Gloss Enamel S-W Pro Industrial Zero VOC Acrylic Semi-Gloss, B66-650 series, Benjamin Moore; Coronado Rust scat Acrylic Semi-Gloss 90 Line, PPG 90-1210 series Pitt-Tech Plus Int./Ext. Semi-Gloss DTM Industrial Enamel
- C. Paint System No. 2:
 - 1. Surface: Interior zinc-coated metal.
 - 2. Thickness: Not less than 2.5 mils.
 - 3. Gloss: Semi-gloss.
 - 4. Primer: Interior/Exterior Rust Inhibitive Primer S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 series, Benjamin Moore; Insul-x Corotech Acrylic Metal Primer V-110, PPG 90-912 Pitt-Tech® Plus Int./Ext. DTM Industrial Primer.
 - 5. 2nd Coat Interior/Exterior Acrylic Semi-Gloss Enamel. S-W Pro Industrial Zero VOC Acrylic Semi-Gloss, B66-650 series, Benjamin Moore; Coronado Rust scat Acrylic Semi-Gloss 90 Line, PPG 90-1210 series Pitt-Tech Plus Int./Ext. Semi-Gloss DTM Industrial Enamel.
 - 6. Finish Coat: Interior/Exterior Acrylic Semi-Gloss Enamel S-W Pro Industrial Zero VOC Acrylic Semi-Gloss, B66-650 series, Benjamin Moore; Coronado Rust scat Acrylic Semi-Gloss 90 Line, PPG 90-1210 series Pitt-Tech Plus Int./Ext. Semi-Gloss DTM Industrial Enamel.
- D. Paint System No. 3:
 - 1. Surface: Interior gypsum board
 - 2. Thickness: Not less than 2.5 mils.
 - 3. Gloss: Eggshell.

4. Primer: S-W, ProMar 200 zero VOC Latex Primer, B28W2600, Benjamin Moore, Ultra Spec 500 Interior Primer N534, PPG 6-4900SPEEDHIDE zero Interior Zero VOC Latex Sealer.
 5. 2nd Coat: S-W, ProMar 200 zero VOC Interior Latex Eg-shel B26-2600 series, Benjamin Moore, Ultra Spec 500 interior paint N538, PPG 6-4310 series Speedhide zero Interior Zero VOC Latex Eggshell
 6. Finish Coat: Same as second coat.
- E. Paint System No. 4:
1. Surface: Interior gypsum board (corridors).
 2. Thickness: Not less than 2.5 mils.
 3. Gloss: Semi-gloss.
 4. Primer: S-W ProMar 200 Interior Latex Primer B28W2600, Benjamin Moore, Ultra Spec 500 N534 Primer, PPG 6-4900 SPEEDHIDE zero Interior Zero VOC Latex Sealer.
 5. 2nd Coat: S-W ProMar 200 zero VOC B26-2600 series, Benjamin Moore, Ultra Spec 500 interior paint N539, PPG 6-4510 series SPEEDHIDE zero Interior Zero VOC Latex Semi-Gloss.
 6. Finish Coat: Same as Second coat
- F. Paint System No. 5:
1. Surface: Aluminum, ferrous metal and zinc surfaces of exposed piping, conduit and fittings, hangers, inserts, cabinets, junction boxes, device covers, uninsulated hot and cold water piping.
 2. Gloss: Semi-gloss.
 3. Primer: Sherwin Williams, Pro Industrial Pro-Cryl Universal Primer, B66-310 series, Benjamin Moore Super Spec HP Acrylic Metal Primer P04, PPG 90-912 Pitt-Tech Plus Int./Ext. DTM Industrial Primer.
 4. Second Coat: Sherwin Williams, Pro Industrial zero VOC Acrylic B66-650, Benjamin Moore, Ultra Spec 500 interior paint N539, PPG 90-1210 series Pitt-Tech Plus Int./Ext. Semi-Gloss DTM Industrial Enamel .
 5. Finish Coat: Same as Second coat.
- G. Pipe and Equipment Identification Schedule:
1. Painting: Paint entire surface of pipe for mechanical and electrical services in accordance with schedule provided on mechanical and electrical drawings and/or contained in mechanical and electrical specifications.

END OF SECTION 099123

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves without waterstop.
2. Sleeves with waterstops.
3. Grout.
4. Silicone sealants.
5. Escutcheons.
6. Contractor coordination.
7. Site examination.
8. Permits
9. Work in existing buildings.
10. Cleaning of systems.

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.
- B. "Approve" - To permit use of material, equipment or methods conditional upon compliance with contract document requirements.
- C. "Concealed" - Hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
- D. "Directed" - Directed by Owner Representative.
- E. "Equal, equivalent" - Possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
- F. "Exposed" - Not concealed.
- G. "Furnish" - Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- H. "Indicated" - Indicated in Contract Documents.
- I. "Install" - Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimensions, finishing, curing, protecting, cleaning and similar operations.
- J. "Piping" - Includes pipe, fittings, valves, supports and accessories comprising a system.
- K. "Provide" - Furnish and install, complete and ready for the intended use.

- L. "Removable" - Detachable from the structure or system without physical alteration of materials or equipment and without disturbance to other construction.
- M. "Review" - Limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.3 ACTION SUBMITTALS

A. Product Data:

- 1. For each type of product.
 - 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. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Contract drawings for plumbing work are diagrammatic, intended to convey scope and general arrangement.
- B. Refer questions involving document interpretation or discrepancies to Owner Representative for review and direction.
- C. Correct faulty work due to resolving discrepancies without proper approval.
- D. Specifications establish quality of materials, equipment, workmanship and methods of construction.
- E. Follow drawings and specifications in laying out work. Consult other applicable contract drawings and specifications, become familiar with conditions affecting work.
- F. Regulations: Comply with regulations of NFPA, county, and municipal building ordinances, and other applicable codes and regulations.
- G. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by the local authority as equivalent in safety to UL labeled equipment.
- H. Material and Equipment Requirements
 - 1. Use products of one manufacturer where two or more items of same kind of materials are required.
 - 2. Materials shall have a record of one-year successful field use.
 - 3. For certain items, the specification and the project design are based upon the specified manufacturer's product. Other manufacturers' names are listed. Contractor may

- purchase, conditional upon meeting project requirements, equipment from the listed manufacturers.
4. Only the manufacturer's equipment upon which the specification and the project design has been based, has been checked for this project. Check allocated space and structure for suitability of equipment of other listed manufacturers, including parts replacement and servicing.
- I. Workmanship
1. Remove and replace, at no extra cost, work not in conformance with contract requirements.
 2. Coordinate work and cooperate with other trades to facilitate execution of work.
- J. Coordination with Other Trades
1. Contractor shall give full cooperation and coordination with other trades and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily with the least possible interference or delay.
 2. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans and shop details for the proper installation of the work and for the purpose of coordination adjacent work.
- K. Asbestos or asbestos-containing materials shall not be utilized or allowed on this project. The Contractor shall be rigorous in ensuring that all materials, equipment, systems, and components do not contain asbestos. Any deviations from this exclusion shall be remedied at the Contractor's expense without regard to prior submittal approvals.
- L. Access: The Contractor shall specifically consider all materials and equipment installations and shall coordinate with the work of all trades to ensure easy and unobstructed accessibility of all systems for operations, maintenance, repairs, and replacement. Installation of all specified materials and equipment including but not limited to, supports and pipe shall be in a manner which will allow complete unobstructed access to all items requiring access for operations or maintenance. All items which require servicing or manual operations for system use shall be located such as to be accessible without standing on other equipment, whenever it is possible or practical. Any installation of new equipment or materials which causes problems related to access of new or existing equipment shall be disapproved by the Owner Representative and re-accomplished by the Contractor.
- 1.6 COORDINATION
- A. References
1. References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.
 2. Refer to applicable contract drawings and specifications pertaining to other Divisions for conditions affecting work.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

2.2 SLEEVES

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 minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CALPICO, Inc.
 - c. GPT; a division of EnPRO Industries.
 - d. Metraflex Company (The).
2. Description: Manufactured galvanized-steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. 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.

D. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) GE Construction Sealants; Momentive Performance Materials Inc.
 - 2) Sherwin-Williams Company (The).
 - 3) The Dow Chemical Company.
 - 4) Tremco Incorporated.

- b. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.
- 2. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
 - a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) Smooth-On.

2.3 ESCUTCHEONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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 or polished brass finish and setscrew fastener.
 - 2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel or brass with polished, chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in 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 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 078413 "Through Penetration Firestop Systems."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. 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.
- B. Secure nailing flanges to wooden concrete forms.
- C. Using grout, seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.3 INSTALLATION OF ESCUTCHEONS

- A. Install escutcheons for piping penetrations of walls and ceilings.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.4 FIELD QUALITY CONTROL

- A. Sleeves:
 - 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves for leaks. Repair leaks and retest until no leaks exist.
 - b. Sleeves 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 for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade:
 - a. 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. Interior Wall 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. Chrome-Plated Piping: One piece, steel, cast brass or split-casting brass with polished, chrome-plated finish.
 - 3. Insulated Piping:
 - a. One piece, steel with polished, chrome-plated or polished brass to match adjacent finish.
 - 4. Bare Piping at Wall Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated or polished brass to match adjacent finish.
 - 5. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated or polished brass to match adjacent finish.
 - 6. Bare Piping in Unfinished Service Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - 7. Bare Piping in Equipment Rooms:
 - a. One piece, steel with polished, chrome-plated finish.

3.7 COORDINATION DRAWINGS

- A. Submit, prior to installation of plumbing systems, six copies of composite working drawings prepared in coordination with other trades at a scale not less than 1/2-inch = 1-foot, clearly showing how work is to be installed in relation to the work of all trades. Contractor shall assist in working out congested space conditions to make a satisfactory adjustment. Drawings shall show the work of all trades (ductwork, conduit, piping, plumbing, lights, equipment, sprinklers, electrical work, etc.) exposed and concealed, including existing mechanical, plumbing, fire protection, and electrical services, coordinated with each other and with the structure. Drawings shall be submitted and bear the Contractors review stamp before any materials are ordered or fabricated.
- B. Work installed before coordinating with other trades or as to cause any interference with work of other trades shall be changed by the Contractor to correct the conditions at their expense.
- C. Drawings shall show existing services where clearances for access are to be maintained.
- D. Relocate existing work or modify location of new work as required to maintain required access and code clearances.

3.8 SITE EXAMINATION

- A. Failure to visit site and become familiar with local conditions prior to bidding will not relieve the Contractor of their responsibility for complying with the Contract Documents.

3.9 PERMITS

- A. Obtain and pay for required permits.

3.10 WORK IN EXISTING BUILDINGS

A. Alterations

1. Cut, alter, remove or temporarily remove and replace existing work necessary for installation of plumbing work. Maintain the necessary clearances for accessibility or compliance with code around existing equipment, devices, etc., that are to remain.
2. Verify dimensions of existing building elements pertaining to the installation of new work to assure physical compatibility prior to fabrication or installation.
3. Where the installation of new services or the extension of existing services requires cutting of existing floors, walls, partitions, etc., check for the presence of existing fire suppression, plumbing, mechanical and electrical services within or immediately beneath construction and exercise necessary precautions to prevent damage to the service or injury to personnel due to contact with same. Where practical, temporarily disconnect such existing service during the cutting operation. Schedule such outages in service with the Owner Representative, 14 days in advance.

B. Connections to Existing Systems

1. Connect to existing systems as indicated.
2. Obtain permission from Owner Representative 14 days in advance if outage of service is necessary to make connections. See the Article titled, "Outages."
3. Repair insulation damaged at points of connection. Restore integrity of vapor barriers and surface finish.

3.11 PROTECTION

- A. Protect plumbing material from the elements or other injury as soon as delivered on premises.
- B. Cap or plug openings in piping dirt and other foreign material. Do not use rags, wool, cotton, paper, waste or similar materials for plugging.
- C. Existing components of the building and its systems shall be protected from damage. Any damage to these components shall be repaired or replaced to the satisfaction of the Owner Representative. Special care shall be taken with regards to insulation on existing piping and ductwork. Damaged insulation shall be replaced so that the vapor barrier and insulating characteristics of the material match those prior to damage taking place.

3.12 CLEANING OF SYSTEMS

- A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently to equipment and other accessory items. Blow out and flush piping until interior are free of foreign matter.
- B. Pay for labor and materials required to locate and remove obstructions from systems clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.
- C. Leave systems clean, and in complete running order.

END OF SECTION 220500

SECTION 220523 – GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ball valves.
 - 2. Check valves.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
 - a. Include material descriptions and dimensions of individual components.
 - b. Include operating characteristics and furnished accessories.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, solder ends, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
 - 4. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Standards:
- B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
 2. ASME B16.18 for cast-copper solder-joint connections.
 3. ASME B16.22 for wrought-copper solder-joint connections.
 4. ASME B31.9 for building services piping valves.
- C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Bypass and Drain Connections: MSS SP-45.
- G. Valve Actuator Type:
1. Hand Lever: For quarter-turn valves smaller than 4 inches.
- H. Valves in Insulated Piping:
1. Ball Valves:
 - a. Provide 2-inch extended neck stems.
 - b. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - c. Memory stops that are fully adjustable after insulation is applied.

2.3 BALL VALVES

2.4 BALL VALVES, GENERAL PURPOSE

- A. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Bray Commercial.
 - c. Jenkins Valves; a Crane Co. brand.
 2. Standard: MSS SP-110; MSS SP-145.
 3. SWP Rating: 150 psig.
 4. CWP Rating: 600 psig.
 5. Body Design: Two piece.
 6. Body Material: Forged brass.
 7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
 8. Seats: PTFE.
 9. Stem: Brass.
 10. Ball: Chrome-plated brass.

11. Port: Full.

2.5 CHECK VALVES, GENERAL PURPOSE

- A. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 150:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Crane Fluid Systems; Crane Co.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Stockham; a Crane Co. brand.
 2. Standard: MSS SP-80, Type 3.
 3. CWP Rating: 300 psig.
 4. Body Design: Horizontal flow.
 5. Body Material: ASTM B62, bronze.
 6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
 7. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

- C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
- D. For valves in horizontal piping, install valves with stem at or above center of pipe.
- E. Install valves in position that does not project into aisles or block access to other equipment.
- F. Install valves in position to allow full stem and actuator or manual operator movement.
- G. Verify that joints of each valve have been properly installed and sealed to ensure there is no leakage or damage.
- H. Check Valves: Install check valves for proper direction of flow.
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
- I. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, 2 inch and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.5 PUMP-DISCHARGE BALL VALVE SCHEDULE

- A. Pipe 2 inch and Smaller:
 - 1. Ball valves, threaded or soldered ends – bronze or brass, two piece with full port and bronze or brass trim.

3.6 PUMP-DISCHARGE CHECK VALVE SCHEDULE

- A. Pipe 2 inch and Smaller for Condensate and Storm Drainage:

1. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal hanger-shield inserts.
5. Fastener systems.

B. Related Requirements:

1. Section 220500 "Common Work Results for Plumbing."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems..

C. Delegated Design Submittals: 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.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses.
 - 1. Design supports for multiple pipes, capable of supporting combined weight of supported systems, system contents, and test water.

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. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Copper Pipe and 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 copper-coated steel or 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. Gripple Inc.
 - e. Unistrut; Atkore International.

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 carbon-steel channel with intumed lips.
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 carbon steel or stainless steel.
8. Paint Coating: Green epoxy, acrylic, or urethane.

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. National Pipe Hanger Corporation.
 5. Pipe Shields Inc.
 6. Piping Technology & Products, Inc.
 7. Rilco Manufacturing Co., Inc.
 8. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
- B. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - d. MKT Fastening, LLC.
2. Indoor Applications: Zinc-coated or stainless steel.
3. Outdoor Applications: Stainless steel.

2.7 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. 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 078413 "Through Penetration Firestop System" 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 INSTALLATION OF HANGERS AND SUPPORTS

- A. Do not support pipes from ducts, other pipes etc.
- B. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- C. Metal Trapeze Pipe-Hanger Installation: This is a delegated design to be completed by the contractor. 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.
- D. Framing System Installation: Metal; This is a delegated design to be completed by the contractor. Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- 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 movement of piping systems, to permit freedom of movement between pipe anchors.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, 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.
- 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. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating Below Ambient Air Temperature: Use Galvanized or Painted thermal hanger-shield insert with clamp sized to match OD of insert.
 - b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. MSS SP-58, Type 39: Install 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 4 and larger if pipe is installed on rollers.

3. MSS SP-58, Type 40: Install 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 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. 1/4 to 3-1/2 inches: 12 inches long and 0.048 inch thick.
 - b. 4 inches: 12 inches long and 0.06 inch thick.
 - c. 5 and 6 inches: 18 inches long and 0.06 inch thick.
5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 METAL FABRICATIONS

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

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup:
 1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those 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 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.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping.
- 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 that will not have field-applied finishes.
- 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 copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.
- G. Use thermal hanger-shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes 1/2 to 30 inches.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes 3/4 to 36 inches, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes 1/2 to 24 if little or no insulation is required.
 - 4. Pipe Hangers (MSS Type 5): For suspension of pipes 1/2 to 4, to allow off-center closure for hanger installation before pipe erection.
 - 5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes 1/2 to 8 inches.
 - 6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes 1/2 to 8.
 - 7. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes 3/8 to 8.
 - 8. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes 3/8 to 3.
 - 9. U-Bolts (MSS Type 24): For support of heavy pipes 1/2 to 30.
 - 10. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 11. Pipe Saddle Supports (MSS Type 36): For support of pipes 4 to 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 12. Pipe Stanchion Saddles (MSS Type 37): For support of pipes 4 to 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 13. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes 2-1/2 to 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 14. Single-Pipe Rolls (MSS Type 41): For suspension of pipes 1 to 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
 - 15. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes 2-1/2 to 24, from single rod if horizontal movement caused by expansion and contraction occurs.

16. Complete Pipe Rolls (MSS Type 44): For support of pipes 2 to 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
 17. Pipe Roll and Plate Units (MSS Type 45): For support of pipes 2 to 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
 18. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes 2 to 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers 3/4 to 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers 3/4 to 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. 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-joist 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.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- N. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe labels.
2. Valve tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Valve-numbering scheme.
- D. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Seton Identification Products; a Brady Corporation company.
- 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: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.2 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Seton Identification Products; a Brady Corporation company.
- B. 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 minimum thickness, with predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire link chain or beaded chain or S-hook.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. 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.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping 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 PIPE LABELS

- A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- B. 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 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 mechanical equipment rooms.
- C. 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.
- D. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe-Label Color Schedule:
 - 1. Storm Drainage: White letters on a black background.
 - 2. Pump Discharge: White letters on a black background.
 - 3. Condensate: White letters on an ANSI Z535.1 safety-green background.

3.4 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, faucets, convenience and lawn-watering hose connections, 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: 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 in the piping system labels and background.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following plumbing piping services:

1. Air Conditioning Condensate
2. Storm-water.
3. Rainwater leaders.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. 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, flanges, valves, and specialties for each type of insulation.
 3. Detail removable insulation at piping specialties.
 4. Detail application of field-applied jackets.

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 another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training. Preference will be given to those who have successfully completed a manufacturer's installation training program, such as the 'Armacell Qualified Installer Program' (AQIP) or similar.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size, as well as ASTM standard designation and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 or UL723, 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 and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General" and "Indoor Piping Insulation Schedule" articles for where insulating materials are applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into 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, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
 3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
 4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 INSULATING CEMENTS

- A. Glass-Fiber Insulating Cement: Comply with ASTM C195.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.
- C. Glass-Fiber Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.

2.4 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. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Foster Brand; H. B. Fuller.

2. Adhesive: As recommended by cellular glass manufacturer and with a VOC content of 80 g/L or less.
 - C. Glass-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Mon-Eco Industries, Inc.
 2. Adhesive: As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.
 - D. ASJ 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, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Mon-Eco Industries, Inc.
 2. Verify adhesives have a VOC content of 80 g/L or less.
 - E. PVC Jacket Adhesive: Compatible with PVC jacket.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 - e. The Dow Chemical Company.
 2. Adhesive: As recommended by Adhesive - PVC Jacket manufacturer and with a VOC content of 50 g/L or less.
- 2.5 MASTICS AND COATINGS
- A. Materials are compatible with insulation materials, jackets, and substrates.
 1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.
 - B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Knauf Insulation.
 - d. Mon-Eco Industries, Inc.
 - e. Vimasco Corporation.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor use on above-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Knauf Insulation.
 - d. Mon-Eco Industries, Inc.
 - e. 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: 0 to plus 180 deg F.
 4. Color: White.

2.6 LAGGING ADHESIVES

- A. Adhesives 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, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Vimasco Corporation.
 2. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of 50 g/L or less.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 4. Service Temperature Range: 20 to plus 180 deg F
 5. Color: White.

2.7 SEALANTS

- A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Mon-Eco Industries, Inc.
 - d. Owens Corning.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 58 to plus 176 deg F.
 4. Color: White or gray.
 5. Verify sealant has a VOC content of 420 g/L or less.
- C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: White.
 5. Verify sealant has a VOC content of 420 g/L or less.

2.8 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.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Airex Manufacturing Inc.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. P.I.C. Plastics, Inc.
 - d. Proto Corporation.
 - e. Speedline Corporation.
 2. Adhesive: As recommended by jacket material manufacturer.

3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, pipe hubs, and mechanical joints.

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Mesh: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
- B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller.
 - b. Vimasco Corporation.

2.11 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, provide products by the following:
 - a. Alpha Associates, Inc.

2.12 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, provide products by one of 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. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor applications.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.

2.13 SECUREMENTS

- A. Bands:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 2. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire Products.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. RPR Products, Inc.

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. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

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 piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, 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.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth, 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. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Testing agency labels and stamps.
 - 2. Nameplates and data plates.
 - 3. Cleanouts.

3.4 PENETRATIONS

- A. 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.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Through Penetration Firestop System" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
 1. Install insulation over fittings, valves, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 7. For services not specified to receive a field-applied jacket, except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Install removable insulation covers at locations that requires removal for maintenance, adjustment, inspection, etc. Installation conforms to the following:
 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF GLASS-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FIELD-APPLIED JACKETS

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. 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.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections: Inspect pipe, fittings, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation is one of the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick. With vapor barrier.
- B. Condensate Drain Water:
 - 1. All Pipe Sizes: Insulation is one of the following:
 - a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick. With vapor barrier.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. ASJ
- D. Piping, Exposed 10 feet or less above finished floor and throughout mechanical equipment rooms.
 - 1. Field-Applied Fabric-Reinforcing Mesh
 - 2. Field-Applied Cloths

END OF SECTION 220719

SECTION 221414 – STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Hubless, cast-iron soil pipe and fittings.
 - 2. Copper tube and fittings.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Hubless, cast-iron soil pipe and fittings.
 - 2. Copper tube and fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and elevations or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.
- B. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Owner Representative no fewer than seven days in advance of proposed interruption of storm drainage service.
 - 2. Do not proceed with interruption of storm drainage service without Owner's Representative written permission.

1.6 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Condensate Drainage, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings:
 - 1. Marked with CISPI collective trademark and NSF certification mark.
 - 2. Standards: ASTM A888 and CISPI 301.
- C. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. Dallas Specialty & Mfg. Co.
 - d. Fernco Inc.
 - e. Ideal Tridon Group.
 - f. Mission Rubber Company, LLC; a division of MCP Industries.
 - 2. Standard: ASTM C1540.
 - 3. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
 - 4. Couplings shall have visual torque indicator to ensure proper installation torque is being applied.

2.4 COPPER TUBE AND FITTINGS

A. Copper Tube:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cambridge-Lee Industries, LLC.
 - b. Cerro Flow Products, LLC.
 - c. Wieland Copper Products, LLC.
2. Copper Tube, Drawn Temper: ASTM B88, Type L and Type M.

B. Copper Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. NIBCO INC.
2. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

C. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C1173.
 - c. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C564 rubber.

- 2) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.
4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
5. Pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - 2) Cascade Waterworks Mfg. Co.
 - 3) EBAA Iron Sales, Inc.
 - 4) Ford Meter Box Company, Inc. (The).
 - 5) JCM Industries, Inc.
 - 6) Romac Industries, Inc.
 - b. Standard: AWWA C219.
 - c. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
 - d. Center-Sleeve Material: Manufacturer's standard.
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
 2. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) A.Y. McDonald Mfg. Co.
 - 2) Capitol Manufacturing Company.
 - 3) GF Piping Systems: Georg Fischer LLC.
 - 4) HART Industrial Unions, LLC.
 - 5) Jomar Valve.
 - 6) Matco-Norca.
 - 7) WATTS; A Watts Water Technologies Company.

- 8) Wilkins.
 - 9) Zurn Industries, LLC.
- b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
- 3. Dielectric Nipples:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - 2) Elster Perfection; Honeywell.
 - 3) Matco-Norca.
 - 4) Precision Plumbing Products.
 - 5) Victaulic Company.
 - b. Description: Electroplated steel nipple.
 - c. Standards: ASTM F492, ASME B1.20.1.
 - d. Pressure Rating: 300 psig at 225 deg F.
 - e. End Connections: Male threaded or grooved.
 - f. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
- B. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- C. Install piping in concealed locations.
 - 1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.

- J. Install piping to allow application of insulation.
- K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
 - 1. Do not change direction of flow more than 90 degrees.
 - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of drainage piping in direction of flow is prohibited.
- L. Install piping at the following minimum slopes unless otherwise indicated.
 - 1. Building Storm Drain: 1/4 inch per foot downward in direction of flow.
 - 2. Horizontal Storm Drainage Piping: 1/4 inch per foot downward in direction of flow.
- M. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Ch IV, "Installation of Cast Iron Soil Pipe and Fittings."
- N. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."
- O. Install force mains at elevations indicated.
- P. Plumbing Specialties:
 - 1. Install cleanouts in storm drainage gravity-flow piping in accessible locations.
 - a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.2 JOINT CONSTRUCTION

- A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.

2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- C. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- D. Joint Restraints and Sway Bracing:
 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
 - c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.3 INSTALLATION OF SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 1. Install transition couplings at joints of piping with small differences in ODs.
 2. In Aboveground Waste Drainage Piping: Shielded, nonpressure transition couplings.
 3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
- B. Dielectric Fittings:
 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 2. Dielectric Fittings for 2 inch and Smaller: Use dielectric unions.

3.4 INSTALLATION OF VALVES.

- A. General valve installation requirements for general-duty valve installation are specified in Section 220523 General Duty Valves for Plumbing Piping.
 1. Install shutoff valve on each condensate pump discharge.
 2. Install full-port ball valve for piping 2 inch and smaller.
- B. Check Valves: Install swing-check valve, between pump and shutoff valve, on each condensate pump discharge.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for hangers, supports, and anchor devices specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. identification
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 5. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 7. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install hangers for cast-iron piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical cast-iron piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor.
 - 2. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections in accordance with the following unless otherwise indicated:
 - 1. Install unions, in piping 2 and smaller adjacent to each valve and at final connection to each piece of equipment.

3.7 IDENTIFICATION

- A. Identify exposed storm drainage piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure:
 - a. Test storm drainage piping on completion of roughing-in.
 - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
 - d. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.

3.10 PROTECTION

- A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day and when work stops.
- C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping 6 and smaller is to be any of the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
- C. Air Conditioning Condensate, Condensate Pump Discharge:
 1. Aboveground: Hard copper tube, Type L copper pressure fittings, and soldered joints.

END OF SECTION 221414

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Miscellaneous storm drainage piping specialties.
 - 2. Cleanouts.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Cleanouts.

1.3 QUALITY ASSURANCE

- A. Provide drainage piping specialties are to bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Cast-Iron Cleanouts:
 - 1. Cast-Iron Exposed Cleanouts.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Jay R. Smith Mfg Co; a division of Morris Group International.
 - 2) MIFAB, Inc.
 - 3) WATTS; A Watts Water Technologies Company.
 - 4) Wade; a subsidiary of McWane Inc.
 - 5) Zurn Industries, LLC.
 - 6) Josam Company.
 - b. Standard: ASME A112.36.2M.
 - c. Size: Same as connected branch.
 - d. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or No-hub, cast-iron soil pipe test tee as required to match connected piping.
 - e. Closure: Countersunk brass plug.
 - f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

2. Cast-Iron Wall Cleanouts.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Jay R. Smith Mfg Co; a division of Morris Group International.
 - 2) MIFAB, Inc.
 - 3) WATTS; A Watts Water Technologies Company.
 - 4) Wade; a subsidiary of McWane Inc.
 - 5) Zurn Industries, LLC.
 - 6) Josam Company.
- b. Standard: ASME A112.36.2M. Include wall access.
- c. Size: Same as connected drainage piping.
- d. Body: Hub-and-spigot, cast-iron soil pipe T-branch or No-hub, cast-iron soil pipe test tee as required to match connected piping.
- e. Closure Plug:
 - 1) Material: Cast iron.
 - 2) Head: Countersunk.
 - 3) Drilled and threaded for cover attachment screw.
 - 4) Size: Same as, or not more than, one size smaller than cleanout size.
- f. Wall-Access Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.
- g. Wall-Access Frame and Cover: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.

3. Cast-Iron Test Tees

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Jay R. Smith Mfg Co; a division of Morris Group International.
 - 2) MIFAB, Inc.
 - 3) WATTS; A Watts Water Technologies Company.
 - 4) Zurn Industries, LLC.
 - 5) Josam Company.
- b. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
- c. Size: Same as connected drainage piping.
- d. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
- e. Closure Plug: Countersunk, brass.
- f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Metal Downspout Nozzles:

- 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. WATTS; A Watts Water Technologies Company.
 - c. Wade; a subsidiary of McWane Inc.
 - d. Zurn Industries, LLC.
 - e. Josam Company.
2. Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor.
 3. Size: Same as connected downspout.
 4. Material: Cast bronze or nickel bronze nozzle and flange.
 5. Piping Connection Type: type to match drainage piping.
 6. Finish: Coordinate with architect.
 7. Opening Protection: Birdscreen.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.
- B. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:
 1. Use cleanouts the same size as drainage piping up to 4. Use 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 3. Locate cleanouts at minimum intervals of 50 ft. for piping 4 and smaller and 100 ft. for larger piping.
 4. Locate cleanouts at base of each vertical storm piping conductor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install test tees in vertical conductors and near floor.
- E. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- F. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
 1. Comply with requirements in Section 078413 "Through Penetration Firestop System."

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 CLEANING

- A. Clean piping specialties during installation and remove dirt and debris as work progresses.

3.4 PROTECTION

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

END OF SECTION 221423

SECTION 230500 - 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. Grout.
5. Silicone sealants.
6. Escutcheons.
7. Thermometers, liquid in glass.
8. Duct-thermometer mounting brackets.
9. Contractor coordination.
10. Site examination.
11. Permits
12. Work in existing buildings.
13. Cleaning of systems.

1.2 DEFINITIONS

- A. "Approve" - To permit use of material, equipment or methods conditional upon compliance with contract document requirements.
- B. "Concealed" - Hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
- C. "Directed" - directed by Owner's Representative.
- D. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
- E. 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.
- F. "Exposed" - not concealed.
- G. "Furnish" - Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- H. "Indicated" - indicated in Contract Documents.
- I. "Install" - Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimensions, finishing, curing, protecting, cleaning and similar operations.
- J. "Piping" - includes pipe, fittings, valves, supports and accessories comprising a system.

- K. "Provide" - furnish and install, complete and ready for the intended use.
- L. "Removable" - detachable from the structure or system without physical alteration of materials or equipment and without disturbance to other construction.
- M. "Review" - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

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. Welding certificates.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of equipment 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.
- C. Contract drawings for mechanical work are diagrammatic, intended to convey scope and general arrangement.
- D. Refer questions involving document interpretation or discrepancies to Owner's Representative for review and direction.
- E. Correct faulty work due to resolving discrepancies without proper approval.
- F. Specifications establish quality of materials, equipment, workmanship and methods of construction.

- G. Follow drawings and specifications in laying out work. Consult other applicable contract drawings and specifications, become familiar with conditions affecting work.
- H. Regulations: Comply with regulations of NFPA, state, county, and municipal building ordinances, and other applicable codes and regulations.
- I. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by the local authority as equivalent in safety to UL labeled equipment.
- J. Material and Equipment Requirements
 - 1. Use products of one manufacturer where two or more items of same kind of equipment are required.
 - 2. Materials and equipment shall have a record of one-year successful field use.
 - 3. For certain items of equipment, the specification and the project design are based upon the specified manufacturer's product. Other manufacturers' names are listed. Contractor may purchase, conditional upon meeting project requirements, equipment from the listed manufacturers.
 - 4. Only the manufacturer's equipment upon which the specification and the project design has been based, has been checked for this project. Check allocated space and structure for suitability of equipment of other listed manufacturers, including parts replacement and servicing.
 - 5. Basis of Design Products: Where the Specifications or Drawings name a specific manufacturer's product accompanied by the words "Basis of Design," including make or model number or other designation, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Naming of a Basis of Design product is intended to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification. The drawings indicate the general size, configuration, location, connections and/or support for equipment or systems specified with relation to the other building systems.
- K. Workmanship
 - 1. Remove and replace, at no extra cost, work not in conformance with contract requirements.
 - 2. Coordinate work and cooperate with other trades to facilitate execution of work.
- L. Coordination with Other Trades
 - 1. Contractor shall give full cooperation and coordination with other trades and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily with the least possible interference or delay.
 - 2. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans and shop details for the proper installation of the work and for the purpose of coordination adjacent work.
- M. Asbestos or asbestos-containing materials shall not be utilized or allowed on this project. The Contractor shall be rigorous in ensuring that all materials, equipment, systems, and components do not contain asbestos. Any deviations from this exclusion shall be remedied at the Contractor's expense without regard to prior submittal approvals.

- N. Access: The Contractor shall specifically consider all materials and equipment installations and shall coordinate with the work of all trades to ensure easy and unobstructed accessibility of all systems for operations, maintenance, repairs, and replacement. Installation of all specified materials and equipment including but not limited to, equipment, supports, pipe, electrical conduit and controls shall be in a manner which will allow complete unobstructed access to all panels, access doors, filter racks, control boxes, controls actuators, sensors, valves, tube bundles and all other items requiring access for operations or maintenance. All items such as controls, actuators and valves which require servicing or manual operations for system use shall be located such as to be accessible without standing on other equipment, whenever it is possible or practical. Any installation of new equipment or materials which causes problems related to access of new or existing equipment shall be disapproved by the Owner's Representative and re-accomplished by the Contractor.

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.
- B. References
1. References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.
 2. Refer to applicable contract drawings and specifications pertaining to other Divisions for conditions affecting work.

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.
- 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 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.
 - e. Provide grounding rings for motor shaft.

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 or Digital Serial Interface (DSI).

2.2 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 minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

B. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, LLC.
 - b. CALPICO, Inc.
 - c. GPT; a division of EnPRO Industries.
 - d. Metraflex Company (The).
2. Description: Manufactured galvanized-steel, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

C. 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.

D. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) GE Construction Sealants; Momentive Performance Materials Inc.

- 2) ITW Polymers 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.

2. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

a. Manufacturers: Subject to compliance with requirements, provide products by the following:

- 1) Smooth-On.

3. Verify sealant has a VOC content of **250** g/L or less.

2.3 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of 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 or polished brass finish and setscrew fastener.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel or brass with polished, chrome-plated finish and spring-clip fasteners.

2.4 THERMOMETERS

A. Thermometers, Liquid in Glass - Metal Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Terice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. Weksler Glass Thermometer Corp.
2. Source Limitations: Provide liquid-in-glass, metal-case, industrial-style thermometers from single manufacturer.
3. Standard: ASME B40.200.

4. Case: Cast aluminum; 4-1/2 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.
8. Window: Glass.
9. Stem: Aluminum and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.

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.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES - GENERAL

- A. Install sleeves for piping passing through penetrations in 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 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 078413 "Through Penetration Firestop System."

3.2 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. Install sleeve with waterstop in exterior walls.
- B. Assemble fitting components of length to be flush with both surfaces of concrete walls. Position waterstop flange centered across width of concrete 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 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 insulated piping and with OD that completely covers opening.

3.4 INSTALLATION OF THERMOMETERS

- A. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.
- B. Install thermometers in the following locations:
 - 1. Outdoor-, return-, and supply-air ducts.

3.5 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.

3.6 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above and below Grade:
 - a. 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. Interior Walls and Partitions:
 - a. Sleeves without waterstops.

3.7 ESCUTCHEONS APPLICATION

- A. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Insulated Piping:
 - a. One piece, steel with polished, chrome-plated or polished brass finish to match adjacent finish.
3. Bare Piping at Wall Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated or polished brass finish to match adjacent finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated or polished brass finish to match adjacent finish.
5. Bare Piping in Unfinished Service Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms:
 - a. One piece, steel with polished, chrome-plated finish.

3.8 THERMOMETER APPLICATION

- A. Thermometers at outside-, return- and supply-air ducts are to be the following:
 1. Industrial-style, liquid-in-glass type.

3.9 THERMOMETER SCALE-RANGE APPLICATION

- A. Scale Range for Air Ducts:
 1. 0 to 150 deg F.

3.10 COORDINATION DRAWINGS

- A. Submit, prior to installation of mechanical systems, six copies of composite working drawings prepared in coordination with other trades at a scale not less than 1/2-inch = 1-foot, clearly showing how work is to be installed in relation to the work of all trades. Contractor shall assist in working out congested space conditions to make a satisfactory adjustment. Drawings shall show the work of all trades (ductwork, conduit, piping, plumbing, lights, equipment, sprinklers, electrical work, etc.) exposed and concealed, including existing mechanical, plumbing, fire protection, and electrical services, coordinated with each other and with the structure. Drawings shall be submitted and bear the Contractors review stamp before any materials are ordered or fabricated.
- B. Work installed before coordinating with other trades or as to cause any interference with work of other trades shall be changed by the Contractor to correct the conditions at their expense.

- C. Drawings shall show existing services where clearances for access are to be maintained.
- D. Relocate existing work or modify location of new work as required to maintain required access and code clearances.

3.11 SITE EXAMINATION

- A. Failure to visit site and become familiar with local conditions prior to bidding will not relieve the Contractor of their responsibility for complying with the Contract Documents.

3.12 PERMITS

- A. Obtain and pay for required permits.

3.13 WORK IN EXISTING BUILDINGS

- A. Alterations
 - 1. Cut, alter, remove or temporarily remove and replace existing work necessary for installation of mechanical and associated electrical work. Maintain the necessary clearances for accessibility or compliance with code around existing equipment, devices, etc., that are to remain.
 - 2. Verify dimensions of existing building elements pertaining to the installation of new work to ensure physical compatibility prior to fabrication or installation.
 - 3. Where the installation of new services or the extension of existing services requires cutting of existing walls, partitions, etc., check for the presence of existing fire suppression, plumbing, mechanical and electrical services within or immediately beneath construction and exercise necessary precautions to prevent damage to the service or injury to personnel due to contact with same. Where practical, temporarily disconnect such existing service during the cutting operation. Schedule such outages in service with the Owner's Representative, 14 days in advance.
- B. Roof Protection: The Contractor shall provide full temporary roof protection for the building's existing roof system during all construction which involves construction on the facility roof. Protection shall consist of full area mats, plywood and other protection devices. No construction shall be performed on areas without protection devices in place. No regular traffic directly on the existing roof shall be permitted. Provide roof guard protection pads for all roof top equipment installed under this contract. Pads shall be compatible with the existing roof system. Roof guard pads shall be 3/4-inch thick, textured surface non-skid type. Construction shall be rubber or neoprene materials. Pads shall be minimum 4-by-5 feet units and shall be secured to the existing roof with compatible adhesives. Pad surface shall be heavy duty, damage resistant. Provide a minimum of 300 square feet of pad for each piece of roof top equipment. Install pads immediately adjacent to equipment; at all regular maintenance locations; and probable walkways to the equipment. Install and secure in accordance with the manufacturer's instructions.

3.14 PROTECTION

- A. Protect mechanical and associated electrical material and equipment from the elements or other injury as soon as delivered on premises. Protect mechanical equipment as soon as they are set.
 - 1. Accept in original packaging.
 - 2. Store in clean, dry space.
 - 3. Protect from dirt, water, construction debris, and traffic.
 - 4. Handle in accordance with manufacturer's written instructions.
- B. Cap or plug openings in equipment, piping, and conduit systems, to exclude dirt and other foreign material. Do not use rags, wool, cotton, paper, waste or similar materials for plugging.
- C. Existing components of the building and its systems shall be protected from damage. Any damage to these components shall be repaired or replaced to the satisfaction of the Owner's Representative. Special care shall be taken with regards to insulation on existing piping and ductwork. Damaged insulation shall be replaced so that the vapor barrier and insulating characteristics of the material match those prior to damage taking place.

3.15 CLEANING OF SYSTEMS

- A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting equipment and other accessory items.
- B. Pay for labor and materials required to locate and remove obstructions from systems clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.
- C. Leave systems clean, and in complete running order.

END OF SECTION 230500

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Requirements:

1. Section 230548 "Vibration Controls for HVAC" for vibration isolation devices.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: 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. Pipe stands.
4. 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.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 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, as defined in Section 014000 "Quality Requirements," 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 medium.
 - 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. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. 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 copper-plated steel or 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. Gripple Inc.
 - f. Unistrut; Atkore International.
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 carbon-steel channel with inturned lips.
 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.
 8. Paint Coating: Green epoxy, acrylic, or urethane.

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. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
- B. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - d. 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 Inc.
 - 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. Low-Profile, Single Base, Single-Pipe Stand:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIRO Industries Inc.
 - b. PHP Systems/Design.
 2. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
 3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 4. Vertical Members: Two, galvanized or stainless-steel, continuous-thread 1/2-inch rods.
 5. Horizontal Member: Adjustable horizontal, galvanized or stainless-steel pipe support channels.
 6. Pipe Supports: Roller, Strut clamps or Clevis hanger.
 7. Hardware: Galvanized or Stainless steel.
 8. Accessories: Protection pads.
 9. Height: 12 inches above roof.
- D. 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.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 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 Section 078413 "Through Penetration Firestop Systems" 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. Do not support pipes or equipment from ducts, pipes, etc.
- B. 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.
- C. Metal Trapeze Pipe-Hanger Installation: This is a delegated design to be completed by the contractor. 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.
- D. Metal Framing System Installation: This is a delegated design to be completed by the contractor. Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Pipe Stand Installation. This is a delegated design to be completed by the contractor.
 - 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 Section 077200 "Roof Accessories" for curbs.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes. This is a delegated design to be completed by the contractor.
- J. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors.

- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves and flanges 2-1/2 and larger and at changes in direction of piping.
- 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 thermal hanger shield inserts if insulation without vapor barrier is indicated.
 - 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 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. 1/4 to 3-1/2 inches: 12 inches long and 0.048 inch thick.
 - 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. This is a delegated design to be completed by the contractor.
- C. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- D. 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 copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.

- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes 1/2 to 30.
 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes 3/4 to 36 inches, requiring clamp flexibility and up to 4 inches of insulation.
 3. Pipe Hangers (MSS Type 5): For suspension of pipes 1/2 to 4 inches, to allow off-center closure for hanger installation before pipe erection.
 4. U-Bolts (MSS Type 24): For support of heavy pipes 1/2 to 30 inches.
 5. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 6. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes 2-1/2 to 36 inches if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 7. Single-Pipe Rolls (MSS Type 41): For suspension of pipes 1 to 30 inches, from two rods if longitudinal movement caused by expansion and contraction might occur.
 8. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes 2-1/2 to 24 inches, from single rod if horizontal movement caused by expansion and contraction might occur.
 9. Complete Pipe Rolls (MSS Type 44): For support of pipes 2 to 42 inches if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
 10. Pipe Roll and Plate Units (MSS Type 45): For support of pipes 2 to 24 inches if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
 11. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes 2 to 30 inches if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers 3/4 to 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers 3/4 to 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 7. 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.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 10. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 3. 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.
- N. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Spring hangers.
3. Snubbers.
4. Restraints - rigid type.
5. Restraints - cable type.
6. Restraint accessories.
7. Post-installed concrete anchors.
8. Restrained isolation roof-curb rails.

1.2 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. Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.
 - c. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.

- d. 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 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.

1.3 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.
 4. The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:

- a. HRU-1
- b. HPU-1, 2, 3
- c. DOAS-1, 2

1.4 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: an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Schedule of Isolation is included in this specification section.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.
 - 1. Wind-Load Performance: Equipment shall withstand the effects of high wind events as indicated on the structural drawings.
- C. 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 factors indicated on structural drawings.
- D. Consequential Damage: Provide additional restraints for anchorage of roof-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.
- E. 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.
- F. Component Supports:
 - 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

- G. Select isolators for uniform static deflections according to distribution of weight and to meet requirements shown elsewhere in the Contract Documents.
- H. Select isolators for not less than the deflections indicated on the Schedule.
- I. Select vibration isolation for stable operation during starting and stopping of equipment without excessive movement of equipment.
- J. Steel Equipment Bases: bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.
 - 1. Fans' vibration bases shall have adjustable motor slide rails to accommodate motor overhang.
 - 2. Bases for exterior use shall be painted or hot-dipped galvanized for complete corrosion resistance.
 - 3. Provide rectangular bases, unless indicated otherwise.
- K. Corrosion Resistance: All springs and associated metal hardware shall be designed or treated for resistance to corrosion. Steel components shall be PVC coated, or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc electroplated. Structural steel bases and exposed steel components of concrete inertia bases shall be cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.
- L. Outdoor Locations: Steel parts PVC coated, hot-dip galvanized, zinc-electroplated plus coating of neoprene, bitumastic paint, or powdered coating. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel. Nuts, bolts, and washers may be zinc-electroplated.
- M. Springs: all springs shall be fully color-coded to indicate capacity, color striping is not considered adequate.

2.2 ELASTOMERIC ISOLATION PADS

A. TYPE D1

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Korfund.
 - c. Mason Industries, Inc.
 - d. VMC GROUP.
 - e. Vibration Eliminator Co., Inc.
- 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 scheduled.
- 5. Pad Material: Oil- and water-resistant rubber.
- 6. Infused nonwoven cotton or synthetic fibers.
- 7. Load-bearing metal plates adhered to pads where necessary to spread loads.
- 8. Sandwich-Core Material: Resilient and elastomeric.

- a. Infused nonwoven cotton or synthetic fibers.

B. TYPE D2

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Korfund.
 - c. Mason Industries, Inc.
 - d. VMC GROUP.
 - e. Vibration Eliminator Co., Inc.
- 2. Same as Type D1, except as follows:
 - a. Cemented steel plate on top with a $\frac{3}{4}$ -inch diameter center hole for bolting through.
 - b. Include a $\frac{3}{4}$ -inch neoprene isolation washer cemented to a steel washer.

2.3 SPRING HANGERS

A. TYPE G

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. VMC GROUP.
 - d. Vibration Eliminator Co., Inc.
- 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 scheduled.
- 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. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.4 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
 - 3. VMC GROUP.
- 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.

2.5 RESTRAINTS - RIGID TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-line; brand of Eaton, Electrical Sector.
 2. Hilti, Inc.
 3. Unistrut; Atkore International.
 4. VMC GROUP.
- 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.

2.6 RESTRAINTS - CABLE TYPE

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

2.7 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-line; brand of Eaton, Electrical Sector.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. 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.

2.8 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Hilti, Inc.
 - c. Mason Industries, Inc.
 - d. Unistrut; Atkore International.
 2. 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, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Hilti, Inc.
 - c. Mason Industries, Inc.
 - d. 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.

2.1 CONCRETE INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-line; brand of Eaton, Electrical Sector.
 - 2. Hilti, Inc.
 - 3. Mason Industries, Inc.
 - 4. 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.

2.2 RESTRAINED ISOLATION ROOF-CURB RAILS – **TYPE P**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc
 - 3. VMC GROUP.
 - 4. Vibration Eliminator Co., Inc.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.
- C. Upper Frame: Shall provide continuous and captive support for equipment.
- D. Lower Support Assembly: Shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside of assembly.

1. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.
 2. Minimum deflection as indicated in schedule.
- E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

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 agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners as follows and where required to prevent buckling of hanger rods due to wind-load forces.
 1. Throughout mechanical equipment rooms but, not less than 50 feet from the isolated equipment where the first 50 feet extends past the mechanical equipment room wall. The pipe shall not come in contact with the wall or sleeve.
 2. For the first 50 feet if not in a mechanical equipment room.
- C. Strength of Support Assemblies: The minimum static deflection of the first three hangers shall equal that of the isolators supporting the equipment. Thereafter, provide isolators with 1/2 the static deflection capabilities of the isolation system of the equipment to which it is connected.

3.3 INSTALLATION OF VIBRATION AND WIND-LOAD CONTROL DEVICES

- A. Provide vibration and wind-load control devices for systems and equipment as scheduled in this section, 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 any requirements for concrete reinforcement and formwork.
- 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 Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- E. Install isolators in locations to permit inspection and adjustment, and to provide proper operation. Install isolators as high as possible in hanger rod assembly, but clear of structure. Maintain 2-inch clearance between isolated equipment and walls, ceilings and other equipment. Maintain side clearance for hanger housings to allow a full 360-degree hanger rotation about the rod axis without contacting any object. Isolated systems shall be independently supported.
- F. Equipment Restraints:
 - 1. Install snubbers or thrust restraint isolation on HVAC equipment mounted on vibration isolators to prevent movement in excess of 1/4-inch due to dynamic forces. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Mount equipment on steel base of adequate structural rigidity when equipment or frame is not structurally suitable for the type of isolation specified. Spring and rail and spring supports are specified on the basis that the equipment is structurally built or supported on a rigid frame.
 - 3. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 4. Install wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- 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 agency acceptable to authorities having jurisdiction 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. Provide structural base plate under isolator where isolator is wider than supporting structural member. Tack weld plate to structural member.
- 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.

3.4 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.

3.5 EQUIPMENT ISOLATION SCHEDULE

- A. If the mount baseplate is bolted to structure or framework rigidly connected to the structure, elastomeric grommets shall be used between each bolt and the baseplate to prevent rigid connection. These additional neoprene washers and bushings may be omitted if the baseplate and friction pad incorporate neoprene elements that eliminate rigid contact between bolts and the baseplate. Bolt holes shall be properly sized to allow for bushing sleeve. The anchor bolt shall incorporate steel washers to distribute load evenly over neoprene washers.
- B. Equipment Isolation Schedule

TYPE OF EQUIPMENT	SUPPORTING STRUCTURE	
	FLOOR AND ROOF	
	ISOLATION BASE TYPE	MIN. STATIC DEFLECTION (IN)
Suspended In-line Centrifugal Fans 500 RPM and Over Note (2)	G	1.5
Air Cooled Condensing Units (HRU and HPU)	D2	0.10
Roof Mounted Package Equipment (DOAS)	P	1.0
Suspended Horizontal Fan Coil Units	G	1.0 Note (1)

NOTES:

1) Spring Deflection.

2) When a fan is suspended, the specified isolation shall be provided in the suspension framework.

C. Piping Isolation

1. Type G Hanger Isolators: Provide on all suspended piping. Type G isolators shall be installed after the pipe is insulated.
2. Provide flexible connection on suction and discharge piping connection to vibration isolated equipment.
3. The installation of vibration isolators shall not cause any change of position of piping, that will result in stresses in piping connections or misalignment of shafts or bearings. Account for changes in height and weight when pipes are filled with medium.
4. Resilient Penetration Sleeve/Seals: Provide penetration seals to maintain an airtight seal

around penetrating elements and to prevent rigid contact of penetrating element and building construction. Fit sleeve tightly to building construction and seal airtight on both sides of construction penetrated with acoustic sealant.

3.6 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.
- C. Adjust leveling bolts and hanger rod bolts so that isolated equipment is level and in proper alignment with connecting ducts and pipes. All vibration isolators shall be aligned squarely above or below mounting points of supported equipment.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. 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's Representative, through Architect, before connecting anchorage device to restrained component (unless post connection 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.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Valve tags.
 - 6. 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, provide products by one of the following:
 - a. Brady Corporation.
 - b. Craftmark Pipe Markers.
 - c. Seton Identification Products; a Brady Corporation company.
 - 2. Material and Thickness: Brass, 0.032-inch minimum thickness, 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. 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, provide products by one of the following:
1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Seton Identification Products; a Brady Corporation company.
- 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 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Seton Identification Products; a Brady Corporation company.

- 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: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Craftmark Pipe Markers.
 - 3. Seton Identification Products; a Brady Corporation company.
- 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 distribution ducts. Arrows may be either integral with label or may be applied separately.
3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.5 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Seton Identification Products; a Brady Corporation company.
- B. 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 minimum thickness, with predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire link chain or beaded chain or S-hook.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. 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.

2.6 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Brady Corporation.
 2. Craftmark Pipe Markers.
 3. Seton Identification Products; a Brady Corporation company.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: 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, ductwork 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.
- E. Equipment requiring identification is all equipment specified in Division 23.

3.4 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- 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. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.

3.5 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-, outdoor-, relief-, and return- -air ducts: White letters on blue background.
- B. 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.

3.6 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: 1-1/2 inch, 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.

3.7 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 and scheduled.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:
 - a. Variable-air-volume systems.
2. Testing, and adjusting of equipment:
 - a. Dedicated Outdoor Air Systems (DOAS)
 - b. Air Cooled VRF Heat Pump Units.
 - c. Air Cooled VRF Heat Recovery Units.
 - d. VRF Fan Coils.
 - e. Fans.
 - f. Unit Heaters.
 - g. Convectors.
3. Vibration tests.
4. Duct leakage tests verification.
5. HVAC-control system verification.

1.2 DEFINITIONS

- A.** AABC: Associated Air Balance Council.
- B.** TAB: Testing, adjusting, and balancing.
- C.** TAB Specialist: An independent entity meeting qualifications to perform TAB work.

1.3 PREINSTALLATION MEETINGS

- A.** TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 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 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 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 30 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. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

- A. Subject to compliance with requirements, engage one of the following:

1. American Testing Inc.
2. Baumgartner, Inc.
3. Chesapeake Testing & Balancing Engineers, Inc.
4. Performance Test and Balance, LLC
5. Protab, Inc.
6. Quality Test and Balance LLC

3.2 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports 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 used for HVAC to verify that they are properly separated from adjacent areas and sealed.
- F. Examine equipment performance data.
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, 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 control valves for proper installation for their intended function of throttling fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine operating safety interlocks and controls on HVAC equipment.
- N. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 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 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. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Cut insulation, ducts, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."

2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation" and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, 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.

3.5 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. Terminal Units.
 2. Dedicated outdoor-air units.
 3. Motors.
 4. Variable-refrigerant-flow systems.
 5. VRF Heat pump units.
 6. VRF Recovery units
 7. VRF Fan coil units.
 8. Unit heaters.
 9. Convectors.
 10. Fans.

3.6 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.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. On constant volume terminals, where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outdoor-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
 - d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outdoor airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

- a. Balance the return-air ducts and inlets.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, speed, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.8 PROCEDURE FOR DOAS SYSTEMS

- A. Follow Procedures for Variable Air Volume Systems
- B. Record nameplate data
- C. Measure and record supply fan cfm.
- D. Measure and record fan static pressure.
- E. Measure and record energy wheel supply EAT DB/WB temperatures.
- F. Measure and record energy wheel supply LAT DB/WB temperatures.
- G. Measure and record energy wheel exhaust EAT DB/WB temperatures.
- H. Measure and record energy wheel exhaust LAT DB/WB temperatures.
- I. Measure, adjust, and record the following data for each refrigerant cooling 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.
- J. Measure, adjust, and record the following data for each refrigerant hot gas reheat 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.
- K. Measure, adjust and record backup electric 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.

3.9 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.

3.10 PROCEDURES FOR AIR-COOLED VRF HEAT PUMP UNITS

- A. Record nameplate data.
- B. Verify proper rotation of fan(s).
- C. Verify Refrigerant charge
- D. Verify Operation in Cooling Mode.
- E. Verify Operation in Heating Mode.
- F. Verify max refrigerant length between Outdoor Unit (ODU) and Indoor Unit (IDU)
- G. Measure and record entering- and leaving-air temperatures.
- H. Measure and record entering and leaving refrigerant pressures.
- I. Measure and record operating data of compressor(s), fan(s), and motors.

3.11 PROCEDURES FOR AIR-COOLED VRF HEAT RECOVERY UNITS

- A. Record nameplate data.
- B. Verify proper rotation of fan(s).
- C. Verify Refrigerant charge

- D. Verify Operation in Cooling Mode.
- E. Verify Operation in Heating Mode.
- F. Verify max refrigerant length between Outdoor Unit (ODU) and Indoor Unit (IDU)
- G. Measure and record entering- and leaving-air temperatures.
- H. Measure and record entering and leaving refrigerant pressures.
- I. Measure and record operating data of compressor(s), fan(s), and motors.

3.12 PROCEDURES FOR VRF FAN COILS

- A. Record nameplate data.
- B. Verify proper rotation of fan(s).
- C. Verify operation of thermostat.
- D. Verify Operation in Cooling Mode.
- E. Verify operation in Heating Mode.
- F. Verify operation of condensate lift mechanism where provided.
- G. 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.
- H. 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.
- I. .
- J. Measure and record operating data of fan(s) and motor(s).

3.13 PROCEDURES FOR UNIT HEATERS

- A. Record nameplate data.
- B. Verify operation of thermostat.
- C. Verify proper rotation of fan.
- D. Measure and record airflow.
- E. Measure and record entering- and leaving-air temperature at full load.
- F. Measure and record air pressure drop.
- G. Measure and record voltage and amperage input of each phase at full load.
- H. Measure and record calculated kilowatt at full load.
- I. Record fuse or circuit-breaker rating for overload protection.

3.14 PROCEDURES FOR CONVECTORS

- A. Record nameplate data.
- B. Verify operation of thermostat.
- C. Measure and record voltage and amperage.
- D. Record fuse or circuit-breaker rating for overload protection.

3.15 PROCEDURE FOR EXHAUST FANS

- A. Record nameplate data.
- B. Verify proper rotation of fan.
- C. Measure and record airflow.
- D. Measure and record voltage and amperage input of each phase at full load.
- E. Measure and record calculated kilowatt at full load.
- F. Record fuse or circuit-breaker rating for overload protection.

3.16 VIBRATION TESTS

- A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.
- B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from AABC's "National Standards for Total System Balance." Acceptable levels of vibration are normally "smooth" to "good."
4. Include in General Machinery Vibration Severity Chart, with conditions plotted.

3.17 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.

3.18 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.

3.19 TOLERANCES

- A. Set HVAC system's airflow 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.

- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.20 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 weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced.

3.21 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. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. 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 energy recovery wheel of DOAS units.
 - 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.
- D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Terminal units.
 4. Balancing stations.
 5. Position of balancing devices.
- E. DOAD-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. 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.
 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. Reheat-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(L/s).
 - k. Return airflow in cfm (L/s).
 - 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. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig.
 - j. Refrigerant suction temperature in deg F.
- G. Electric-Coil Test Reports: For 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.
 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.
 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 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 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-air temperature in deg F.
- c. 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.

3.22 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
- B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
 - 2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.
- F. Prepare test and inspection reports.

3.23 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 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 - 7. Outdoor, concealed supply and return.
 - 8. Outdoor, exposed supply and return.
- B. Related Requirements:
 - 1. Section 230719 "HVAC Piping Insulation."

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 Section 230529 "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.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 or UL723, 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 III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of 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. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of 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, provide products by one of 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. Glass-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of 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).
- C. 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, provide products by one of 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).

2.4 MASTICS AND COATINGS

- A. Materials are compatible with insulation materials, jackets, and substrates.
 - 1. VOC Content: 300 g/L or less.
- B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Exterior Use: Suitable for outdoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller.
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 50 to plus 220 deg F.
4. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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, provide products by one of 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. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper 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. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. Metal Jacket:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Mesh: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Vimasco Corporation.
- 2.10 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, provide products by the following:
 - a. Alpha Associates, Inc.
- 2.11 TAPES
- A. 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, provide products by one of 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.
 - B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

2.12 SECUREMENTS

A. Bands:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
- 2. Stainless Steel: ASTM A240/A240M, Type 316; 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 and Hangers:

- 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.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) CL WARD & Family Inc.
 - 3) Gemco.
 - 4) Midwest Fasteners, Inc.
 - 5) Nelson Stud Welding.

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, provide products by one of the following:
 - a. C & F Wire Products.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. RPR Products, Inc.

2.13 CORNER ANGLES

- A. 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.
- B. Stainless Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel in accordance with ASTM A240/A240M, Type 316.

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, 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.
- 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. Vapor barrier installation: 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. 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 078413 "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 078413 "Penetration Firestopping."

3.5 INSTALLATION OF GLASS-FIBER 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, for 50 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, 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, 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 60 deg Fat 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 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, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums, 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 60 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 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 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 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Comply with manufacturer's written installation instructions.
- B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- C. Insulate duct access panels and doors to achieve same fire rating as duct.

- D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.8 FINISHES

- A. Insulation with Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099123 "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. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum jackets.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 - 7. Outdoor, concealed supply and return.
 - 8. Outdoor, exposed supply and return.
- B. Plenums and Ducts Requiring Vapor Barrier:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.

5. Outdoor, concealed supply and return.
6. Outdoor, exposed supply and return.

C. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round, supply-air duct insulation is the following:

1. Glass-Fiber Blanket: 2-3/16 inches thick and 0.75 lb/cu. ft. nominal density.

B. Concealed, round, return-air duct insulation is the following:

1. Glass-Fiber Blanket: 2-3/16 inches thick and 0.75 lb/cu. ft. nominal density.

C. Concealed, round, outdoor-air duct insulation is the following:

1. Glass-Fiber Blanket: 3 inches thick and 0.75 lb/cu. ft. nominal density.

D. Concealed, round, exhaust-air duct insulation is the following:

E. Glass-Fiber Blanket: 2-3/16 inches thick and 0.75 lb/cu. ft. nominal density
Concealed, rectangular, supply-air duct insulation is the following:

1. Glass-Fiber Blanket: 2-3/16 inches thick and 0.75 lb/cu. ft. nominal density.

F. Concealed, rectangular, return-air duct insulation is the following:

1. Glass-Fiber Blanket: 2-3/16 inches thick and 0.75 lb/cu. ft. nominal density.

G. Concealed, rectangular, outdoor-air duct insulation is the following:

1. Glass-Fiber Blanket: 3 inches thick and 0.75 lb/cu. ft. nominal density.

H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior is the following:

1. Glass-Fiber Blanket: 3 inches thick and 0.75 lb/cu. ft. nominal density.

I. Concealed, supply-air plenum insulation is the following:

1. Glass-Fiber Blanket: 2-3/16 inches thick and 0.75 lb/cu. ft. nominal density.
2. Glass-Fiber Blanket: 2-3/16 inches thick and 0.75 lb/cu. ft. nominal density.

- J. Concealed, outdoor-air plenum insulation is the following:
 - 1. Glass-Fiber Blanket: 3 inches thick and 0.75 lb/cu. ft. nominal density.
- K. Concealed, exhaust-air plenum insulation is the following:
 - 1. Glass-Fiber Blanket: 3 inches thick and 0.75 lb/cu. ft. nominal density.
- L. Exposed, round, supply-air duct insulation is the following:
 - 1. Glass-Fiber Pipe and Tank: 2 inches thick.
- M. Exposed, round, return-air duct insulation is the following:
 - 1. Glass-Fiber Pipe and Tank: 2 inches thick.
- N. Exposed, round, outdoor-air duct insulation is the following:
 - 1. Glass-Fiber Pipe and Tank: 3 inches thick.
- O. Exposed, round, exhaust-air duct insulation is the following:
 - 1. Glass-Fiber Pipe and Tank: 2 inches thick.
- P. Exposed, rectangular, supply-air duct insulation is the following:
 - 1. Glass-Fiber Board: 1-1/2 inches thick and 1.6lb/cu. ft. nominal density.
- Q. Exposed, rectangular, return-air duct insulation is the following:
 - 1. Glass-Fiber Board: 1-1/2 inches thick and 1.6lb/cu. ft. nominal density.
- R. Exposed, rectangular, outdoor-air duct insulation is the following:
 - 1. Glass-Fiber Board: 2 inches thick and 1.6 lb/cu. ft. nominal density.
- S. Exposed, rectangular, exhaust-air duct insulation is the following:
 - 1. Glass-Fiber Board: 1-1/2 inches thick and 1.6lb/cu. ft. nominal density.
- T. Exposed, supply-air plenum insulation is the following:
 - 1. Glass-Fiber Board: 1-1/2 inches thick and 1.6lb/cu. ft. nominal density.
- U. Exposed, return-air plenum insulation is the following:
 - 1. Glass-Fiber Board: 1-1/2 inches thick and 1.6lb/cu. ft. nominal density.
- V. Exposed, outdoor-air plenum insulation is the following:
 - 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- W. Exposed, exhaust-air plenum insulation is the following:

1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.

3.12 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round, supply-air duct insulation is the following:
 1. Glass-Fiber Blanket: 3 inches thick and 0.75 lb/cu. ft. nominal density.
- B. Concealed, round, return-air duct insulation is the following:
 1. Glass-Fiber Blanket: 3 inches thick and 0.75 lb/cu. ft. nominal density.
- C. Concealed, round, outdoor-air duct insulation is the following:
 1. Glass-Fiber Blanket: 3 inches thick and 0.75 lb/cu. ft. nominal density.
- D. Concealed, rectangular, supply-air duct insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- E. Concealed, rectangular, return-air duct insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- F. Concealed, rectangular, outdoor-air duct insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- G. Concealed, rectangular, exhaust-air duct insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- H. Concealed, supply-air plenum insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- I. Concealed, return-air plenum insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- J. Concealed, outdoor-air plenum insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- K. Concealed, exhaust-air plenum insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- L. Exposed, round, supply-air duct insulation is the following:
 1. Glass-Fiber Pipe and Tank: 3 inches thick.
- M. Exposed, round, return-air duct insulation is/ one of/ the following:

1. Glass-Fiber Pipe and Tank: 3 inches thick.
 - N. Exposed, round, supply-air duct insulation is the following:
 1. Glass-Fiber Pipe and Tank: 3 inches thick.
 - O. Exposed, rectangular, supply-air duct insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
 - P. Exposed, rectangular, return-air duct insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
 - Q. Exposed, rectangular, outdoor-air duct insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
 - R. Exposed, rectangular, exhaust-air duct insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
 - S. Exposed, supply-air plenum insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
 - T. Exposed, return-air plenum insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
 - U. Exposed, outdoor-air plenum insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
 - V. Exposed, exhaust-air plenum insulation is the following:
 1. Glass-Fiber Board: 2 inches thick and 1.6lb/cu. ft. nominal density.
- 3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE
- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
 - B. If more than one material is listed, selection from materials listed is Contractor's option.
 - C. Ducts and Plenums, Concealed:
 1. FSK
 - D. Ducts and Plenums, Exposed in mechanical equipment rooms:
 1. Field-Applied Fabric-Reinforcing Mesh
 2. Field-Applied Cloths

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Ducts and Plenums, Concealed:
 - 1. Aluminum, Stucco Embossed: 0.024 inch thick.
- C. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Aluminum, Stucco Embossed: 0.024 inch thick.
- D. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
 - 1. Stucco Embossed with 4-by-1-Inch Box Ribs: 0.032 inch thick.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulation for HVAC piping systems.
- B. Related Requirements:
 - 1. Section 220719 "Plumbing Piping Insulation" for condensate piping insulation.
 - 2. Section 230713 "Duct Insulation" for duct insulation.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. 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 and fittings for each type of insulation.
 - 3. Detail removable insulation at piping specialties.
 - 4. Detail application of field-applied jackets.

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, certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size, as well as ASTM standard designation, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 or UL723 by a testing agency acceptable to authority 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 and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, and Aboveground Piping Insulation Schedule," articles for where insulating materials are applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into 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. Flexible Elastomeric: 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.

2.3 INSULATING CEMENTS

- A. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.

2.4 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: 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. Adhesive: As recommended by flexible elastomeric and polyolefin manufacturer and with a VOC content of 80 g/L or less.
3. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
4. Wet Flash Point: Below 0 deg F.
5. Service Temperature Range: 40 to 200 deg F.
6. Color: Black.

2.5 MASTICS AND COATINGS

- A. Materials are compatible with insulation materials, jackets, and substrates.

1. Mastics: As recommended by insulation manufacturer and with a VOC content of 50 g/L or less.

- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

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

- a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Knauf Insulation.
 - d. Mon-Eco Industries, Inc.
 - e. Vimasco Corporation.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: 0 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. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Color: White.
 - D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Knauf Insulation.
 - d. Mon-Eco Industries, Inc.
 - e. 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: 0 to plus 180 deg F.
 4. Color: White.
- 2.6 LAGGING ADHESIVES
- A. Adhesives 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, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Vimasco Corporation.

2. Verify adhesive is as recommended by insulation manufacturer and has a VOC content of 50 g/L or less.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 20 to plus 180 deg F.
5. Color: White.

2.7 SEALANTS

- A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Mon-Eco Industries, Inc.
 - d. Owens Corning.
 2. Permanently flexible, elastomeric sealant.
 - a. Service Temperature Range: Minus 150 to plus 250 deg F.
 - b. Color: White or gray.
 3. Verify sealant has a VOC content of 420 g/L or less.
- C. Metal Jacket Flashing Sealants:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Mon-Eco Industries, Inc.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
 5. Verify sealant has a VOC content of 420 g/L or less.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.
- B. Metal Jacket:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
2. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
- a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 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.

C.

2.9 FIELD-APPLIED FABRIC REINFORCING MESH

- A. Woven Glass-Fiber Mesh: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
- a. Childers Brand; H. B. Fuller Construction Products.
- B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller.
 - c. Vimasco Corporation.

2.10 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, provide products by the following:

- a. Alpha Associates, Inc.

2.11 TAPES

- A. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of 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: 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.

2.12 SECUREMENTS

- A. Bands:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
- 2. Stainless Steel: ASTM A240/A240M, Type 316; 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.

- A. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

- B. Wire: 0.062-inch soft-annealed, stainless steel.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire Products.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. RPR Products, Inc.

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. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

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 piping, including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, 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 the Contract Documents.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth, 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. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 2 inches o.c.
 4. For below-ambient services, apply vapor-barrier mastic over staples.
 5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.

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: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.
- B. Insulation Installation on Fittings, Valves, Strainers, Mechanical Couplings, and Unions:
1. Install insulation over fittings, valves, strainers, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using prefabricated fitting insulation or mitered or routed fittings made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with prefabricated fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using prefabricated fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced

- without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- C. Insulate instrument connections for pressure gages, test connections, sensors, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers. Installation conforms to the following:
1. Make removable union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
 2. When union covers are made from sectional pipe insulation, extend insulation from union at least 2 times the insulation thickness over adjacent pipe insulation on each side of union. Secure cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for unions, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to union with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Installation shall follow the manufacturer's installation instructions or ASTM C 1710.
- B. 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.
- C. Insulation Installation on Pipe Flanges:
1. Slit tubular sections and apply onto piping or tubing. Alternatively, slide un-slit sections over the open ends of piping or tubing.
 2. 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.
 3. Insulation must be installed in compression to allow for expansion and contraction.
 4. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
 5. For below-ambient systems, adhere the insulation to the pipe at least every 18 feet using manufacturer's adhesive. Completely terminate joints at critical points such as flanges, T-sections, elbows, supports, and similar fittings.
- D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
3. 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.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

3.7 INSTALLATION OF FIELD-APPLIED JACKETS

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 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.

3.8 FINISHES

A. Insulation with Glass-Cloth or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099123 "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 jackets.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings,

three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

- C. All insulation applications will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.
- B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.
- C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 1 inch thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 2 inches thick.
- C. Refrigerant Liquid Piping:
 - 1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 2 inches thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation is the following:

- a. Flexible Elastomeric: 2 inches thick.
 - C. Refrigerant Liquid Piping:
 - 1. All Pipe Sizes: Insulation is the following:
 - a. Flexible Elastomeric: 2 inches thick.
- 3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE
- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
 - B. If more than one material is listed, selection from materials listed is Contractor's option.
 - C. Piping, Concealed:
 - 1. ASJ
 - D. Piping, Exposed in mechanical equipment rooms:
 - 1. Field-Applied Fabric-Reinforcing Mesh
 - 2. Field-Applied Cloths
- 3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
 - B. Piping, Concealed:
 - 1. Aluminum, Stucco Embossed: 0.024 inch thick.
 - C. Piping, Exposed:
 - 1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC & HVAC CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes Commissioning Process (Cx Process) requirements for Division 23 Sections for HVAC equipment, systems, and control requirements.
- B. Commissioning requirements common to all Sections are specified in Section 019113 General Commissioning Requirements and detailed in the Commissioning Plan (Cx Plan).

1.2 GENERAL DESCRIPTION

- A. Commissioning of the HVAC & HVAC Control Systems will be performed by a certified Commissioning Agent (CxA) under a separate Contract with the Owner. The Mechanical Contractor (MC), Automatic Temperature Controls Contractor (ATC), Testing, Adjusting, and Balancing (TAB) Contractor, and Electrical Contractor (EC) shall assist the CxA as required in Section 019113 General Commissioning Requirements.
- B. Contractor shall be responsible for all costs incurred by the Owner due to Contractor's failure to perform any of its responsibilities pursuant to this section.

1.3 SCOPE

- A. Systems to be Commissioned under this section include:
 - 1. HVAC Systems and Controls for:
 - a. Dedicated Outdoor Air Unit systems along with all associated Variable Air Volume Supply Air Terminals and Exhaust Air Terminal Units.
 - b. Variable Refrigerant Volume systems along with all associated Variable Refrigerant Heat Recovery Units, Variable Refrigerant Heat Pump Units, Variable Refrigerant Branch Controller Boxes, and Variable Refrigerant Fan Coil Units.
 - c. Convectors.
 - d. Unit Heaters,
 - e. Exhaust Fans.

1.4 COMMISSIONING TEAM

- A. Members Appointed by Contractor (s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to,

representative of each contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The entity identified by the Owner that leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
2. Representatives of the building operations personnel.
3. Architect and engineering design professionals.

1.5 OWNER'S RESPONSIBILITIES

- A. Provide the OPR documentation to the CxA and each contractor for information and use.
- B. Assign building operations personnel and schedule them to participate in commissioning team activities. Coordinate activities specified in paragraph below with Owner-Architect and Architect-Consultant agreements.
- C. Provide the BoD documents, prepared by Engineer of Record and approved by Owner, to the CxA and each contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.6 CONTRACTORS RESPONSIBILITIES

- A. Each Contractor and their subcontractors shall assign representatives with expertise and authority to act on their behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to the following:
 1. Evaluate performance deficiencies identified in field observation or test reports and, in collaboration with entity responsible for system and equipment installation. Recommend corrective action.
 2. Cooperate with CxA for resolution of issues recorded in Issues Log.
 3. Attend and participate in commissioning team meetings held during construction.
 4. Integrate and coordinate commissioning process activities with the construction schedule.
 5. Review and accept pre-functional checklists (PFCs) provided by the CxA.
 6. Complete PFCs as work progresses and provide to the CxA, along with manufacturer startup documentation.
 7. Review and comment on Functional Performance Test (FPT) procedures provided by the CxA.
 8. Complete Functional Performance Test Readiness Checklist, provided by CxA, to confirm readiness for functional testing.
 9. Ensure that manufacturer's technicians for the equipment to be commissioned are on site for Functional Performance Testing.

1.7 COMMISSIONING AGENT RESPONSIBILITIES

- A. Organize and lead the commissioning team. Convene commissioning team meetings and distribute meeting minutes.
- B. Provide the Commissioning Plan (Cx Plan), including project-specific construction checklists and commissioning process test procedures for HVAC & HVAC control systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- C. Monitor testing, adjusting, and balancing (TAB) work.
- D. Monitor equipment start-up and verification.
- E. Prepare and maintain Issues Log.
- F. Coordinate start-up, FPTs, and training schedules with the Contractor and project team.
- G. Direct Functional Performance Tests (FPTs).
- H. Provide test data, commissioning reports, and documentation in the Systems Manual.

1.8 RELATED WORK AND DOCUMENTS

- A. Commissioning Plan (Cx Plan): The Commissioning Plan is a document prepared by the CxA that outlines the activities, sequencing and documentation of all Cx activities.
- B. OPR and BoD documentation are included as reference for information only.
- C. Division 01, including Section 019113 - General Commissioning Requirements.
- D. Division 22 in its entirety.
- E. Division 23 in its entirety.
- F. Division 26 in its entirety.

1.9 REFERENCE STANDARDS

- A. Provided in 019113 General Commissioning Requirements.

1.10 COMMISSIONING DOCUMENTATION PROVIDED BY CONTRACTOR

- A. Provide the following information to the Commissioning Agent (CxA) for inclusion in the Commissioning Plan (Cx Plan) and Cx Report.
 - 1. Plan for delivery of submittals, start-up reports, and other specified documents and reports.

2. Identification and labeling of installed systems, assemblies, equipment, and components including design changes that occurred during the Construction Phase.
3. Process and schedule for completing construction checklists and manufacturer's pre-start and start-up checklists for HVAC systems, assemblies, equipment, and components to be verified and tested.
4. Completion of CxA checklists certifying that installation, pre-start checks, and start-up procedures have been completed.
5. Manufacturer's start-up reports certifying that HVAC systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action and service report documents.
8. Testing, adjusting, and balancing (TAB) reports.

PART 2 - PRODUCTS

- A. Per Specification 019113 General Commissioning Requirements.

PART 3 - EXECUTION

3.1 RESPONSIBILITIES

- A. Contractor responsibilities during the commissioning process are identified in section 019113, General Commissioning Requirements.
- B. The following requirements pertain specifically to the ATC Contractor and TAB Contractor.
 1. ATC Contractor requirements include the following:
 - a. Include cost for commissioning support in the quoted price.
 - b. Designate a Cx Coordinator who is authorized to direct the work and make commissioning-related schedule and scope of work decisions.
 - c. Review design for controllability with respect to equipment selected for the project.
 - d. Review and confirm that proper safeties and interlocks are included in the design.
 - e. Ensure the proper selection of sensor ranges, and include data with submittal to mechanical engineer.
 - f. Participate in controls coordination meetings as required by the CxA.
 - g. Clarify all questions concerning sequences of operation.
 - h. Attend commissioning meetings scheduled by the CxA.
 - i. Provide control system technician to assist during system verification and Functional Performance Testing.
 - j. Coordinate with General Contractor to integrate controls installation and programming activities into the construction schedule and commissioning process.
 - k. Inspect, check and confirm the correct installation and operation of input and output field points and devices through documented and signed off point-to-point checkouts. Provide completed point-to-point checkouts to CxA prior to functional testing.
 - l. Provide training to operations personnel as required by the specifications.

- m. In conjunction with the Plumbing Contractor, demonstrate system performance to the CxA, including all modes of system operation, during Functional Performance Testing.
 - n. If incomplete installation or programming affecting system performance is discovered, the FPTs will be stopped by the CxA. Those responsible for deficient or incomplete work will be responsible for correcting the deficiencies and absorbing the cost of retesting.
 - o. Provide support of and coordination with TAB contractor on all interfaces between controls and TAB scopes of work. Provide, at no additional cost to TAB and Cx agencies, all devices, such as portable operator's terminals and all software for the TAB agency to use in completing TAB procedures.
2. TAB Contractor shall perform the following activities:
- a. Include costs for commissioning support in the quoted price.
 - b. Attend commissioning meetings scheduled by the Contractor prior to, and during, on-site performance of TAB activities.
 - c. Submit proposed TAB procedures to the CxA and plumbing engineer for review and acceptance.
 - d. Attend the TAB planning meeting scheduled by the CxA. Be prepared to discuss the procedures to be followed in testing, adjusting and balancing the plumbing systems.
 - e. At the completion of the TAB work, submit the final TAB report to the General Contractor with copies to the Owner, CxA and Engineer.
 - f. Participate in verification of the TAB report by the CxA for verification or diagnostic purposes. This will consist of repeating a sample (normally 10% to 20%) of the measurements contained in the TAB report as selected by the CxA.
 - g. Participate in O & M personnel training sessions required by specifications.

3.2 PRE-FUNCTIONAL CHECKLISTS, STARTUP AND INITIAL CHECKOUT

- A. At least four weeks prior to startup, the Contractor shall schedule installing contractors and vendors for equipment startup and checkout, notifying the CxA of the dates and times of startups.
- B. The CxA shall observe the startup for select primary equipment, unless there are multiple units (in which case a sampling strategy may be used).
- C. The installing contractors and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed startup and pre-functional checklists.
- D. Only individuals that have witnessed performance of a line-item task on the pre-functional checklist shall initial or check off that item as complete.
- E. Clearly list any outstanding items from the initial startup and pre-functional procedures that were not completed successfully. The completed startup procedures, signed pre-functional checklists, and any outstanding deficiencies shall be provided to the CxA within a week of startup.
- F. The responsible subcontractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner. The GC shall notify the CxA as soon as outstanding items

have been corrected and resubmit an updated startup report and a confirmation of correction on the original non-compliance report.

- G. Deficient items identified during completion of pre-functional checklists or initial startup that are not corrected, and which later cause deficiencies or delays during Functional Performance Testing, shall result in back charges to the responsible subcontractor for the CxA's time to perform any retesting. The installing subcontractor shall be responsible for performing retests of deficient pre-functional or functional tests at its own cost.

3.3 TESTING PREPARATION

- A. Certify that heating, ventilation, and air-conditioning (HVAC) systems, subsystems, and equipment has been installed, calibrated, and started and are operating according to the Contract documents.
- B. Certify that HVAC installation and control systems have been completed and calibrated, that they are operating according to the Contract documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation
- G. Coordinate power failure and return to normal operation testing with the applicable emergency power provisions.

3.4 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing, adjusting, and balancing (TAB) work, provide copies of reports, sample forms, checklists, and certificates to the Commissioning Agent (CxA).
- B. Notify the CxA at least ten (10) days in advance of TAB work, and provide access for the CxA to witness TAB work.
- C. Provide technicians, instrumentation, and tools to verify the testing, adjusting, and balancing of the HVAC system in the field at the direction of the CxA.

- D. The CxA will notify the Testing, Adjusting, and Balancing (TAB) Agency ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
- E. The TAB Agency will use the same instruments (by model and serial number) that were used when original data were collected.
- F. Failure of an item includes a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final TAB Report.
- G. Remedy the deficiency and notify the CxA so verification of correction and proper installation and/or operation can be performed.

3.5 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA in accordance with Section 019113 General Commissioning Requirements.
- B. Scope of plumbing testing shall include the entire plumbing installation. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all safeties, alarms, operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of controllers and sensors.
- D. The CxA along with the Mechanical Contractor (MC), Automatic Temperature Controls Contractor (ATC), Testing, Adjusting, and Balancing (TAB) Agency, Plumbing Contractor [if different from mechanical contractor] and installing vendor(s) shall prepare detailed testing plans, procedures, and checklists for mechanical and plumbing systems, subsystems, and equipment.
- E. Tests will be performed using design loads whenever possible.
- F. Simulating conditions (not by overwriting values) shall be allowed, though timing the testing to experience actual conditions is encouraged, wherever practical. Altering setpoints to test a sequence is acceptable. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The installing contractor is responsible for returning all temporary building system modifications to pre-test conditions.
- G. Simulated loads testing will be verified with actual loads testing by scheduling deferred or off-season mode testing when conditions are suitable during initial FPTs.
- H. If tests cannot be completed because of a deficiency outside the scope of work, document the deficiency and report it to the Owner and Designer of Record as soon as possible. After deficiencies are resolved, reschedule tests.
- I. Items identified as deficient during pre-functional checkout and initial startup, but not corrected, that later cause deficiencies or delays during Functional Performance Testing, will result in back charges to the responsible contractor for the CxA's time to perform retesting. The installing contractor shall be responsible for performing retests of deficient functional tests at its own cost.

- J. If the Cx Plan indicates specific warranty period testing and/or training, complete appropriate initial Functional Performance Tests and/or training and documentation and schedule seasonal tests and/or training.

3.6 FUNCTIONAL PERFORMANCE TESTING

- A. The Contractor shall provide a minimum of two weeks' notice to the CxA regarding its completion schedule for the pre-functional checklists and startup of all equipment and systems. Contractor is responsible for forwarding completed pre-functional checklists and startup documentation to the CxA and scheduling Functional Performance Tests with all parties.
- B. The CxA shall coordinate, witness, and document the functional testing of all equipment and systems. The installing contractors shall execute the tests.
- C. Functional testing is conducted after pre-functional checklists and startup documentation have been satisfactorily completed. The control system, if any, shall be sufficiently tested and completed checkouts issued before it is used for TAB activities or to verify performance of other components or systems. Water balancing must be completed prior to Functional Performance Testing of water-related equipment or systems.

3.7 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: The CxA shall witness and document the results of all FPTs using the forms developed for that purpose. Prior to testing, these forms must be provided to the Contractor and subcontractors for review and comment. The CxA shall update forms as necessary and use them during testing.
- B. Non-Conformance:
 - 1. The CxA will record the results of the FPTs on the test forms. All deficiencies or non-conformance issues shall be noted and reported to the Contractor and project team on the Commissioning Issues Log. Corrections of minor deficiencies identified may be made during testing at the discretion of the CxA. In such cases the deficiency and its resolution will be documented on the test form.
 - 2. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the Cx process. The CxA will not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost restrictions, unless there is an overriding reason to do so and at the request of the Owner.
 - 3. The CxA documents the deficiency and the subcontractor's response and moved on to another test or sequence. After the day's work, the CxA reports the deficiency on the Commissioning Issues Log, a copy of which is provided to the Contractor and subcontractors. The subcontractor corrects the deficiency, signs a statement of correction certifying that the equipment is ready to be retested and sends it back to the CxA.
 - 4. The CxA reschedules the test and the test is repeated.

3.8 TRAINING

- A. The Contractor shall be responsible for training coordination and scheduling, and ultimately for ensuring that training is completed.
- B. The CxA shall be responsible for reviewing and confirming the content and adequacy of the training of Owner personnel for the commissioned equipment.
- C. Each subcontractor and vendor responsible for training will submit a written training plan to the CxA for review and approval prior to training. The plan will cover the following elements:
 - 1. Equipment (included in training).
 - 2. Sign-in sheet.
 - 3. Intended audience.
 - 4. Location of training.
 - 5. Objectives.
 - 6. Subjects covered (description, duration of discussion, special methods, etc.).
 - 7. Duration of training for each topic.
 - 8. Identification of the instructor for each subject and their qualifications.
 - 9. Method(s) of instruction (classroom lecture, video, site walk-through, operational demonstrations, written handouts, etc.).
- D. A sign-in sheet completed by attendees shall be submitted to the CxA for proof of training.

END OF SECTION 230800

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Direct digital control (DDC) system for HVAC.
- B. Related Requirements:
 - 1. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical power and communications components

1.2 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 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.
- D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- E. 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 indicated: network controllers, programmable application controllers, and application-specific controllers.
- F. 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.
- G. COV: Changes of value.
- H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

- I. 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 to be capable of operating in a standalone mode using the last best available data.
- J. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- K. HLC: Heavy load conditions.
- L. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). 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. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- M. LAN: Local area network.
- N. 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.
- O. 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.
- P. Modbus TCP/IP: An open protocol for exchange of process data.
- Q. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- R. MTBF: Mean time between failures.
- S. 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.
- T. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- U. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- V. POT: Portable operator's terminal.
- W. RAM: Random access memory.
- X. RF: Radio frequency.
- Y. Router: Device connecting two or more networks at network layer.
- Z. Server: Computer used to maintain system configuration, historical and programming database.
- AA. TCP/IP: Transport control protocol/Internet protocol.
- BB. UPS: Uninterruptible power supply.

- CC. USB: Universal Serial Bus.
- DD. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- EE. VAV: Variable air volume.
- FF. WLED: White light emitting diode.

1.3 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first 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 indicated 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.

B. Product Data:

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 effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
 - a. Workstations.
 - b. Printers.
 - c. Servers.
 - d. Gateways.
 - e. Routers.
 - f. DDC controllers.
 - g. Enclosures.
 - h. Electrical power devices.
 - i. UPS units.
 - j. Accessories.
 - k. Instruments.
 - l. Control dampers and actuators.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.

7. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

C. 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.
2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, 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 indicated.
 - c. Each desktop workstation network port, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
 - d. Network communication cable and raceway routing.
 - e. Proposed routing of wiring, cabling, conduit, and tubing; coordinated with building services for review 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, if included in Project.
 - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
 - 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 to 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. Narrative sequence of operation.
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. Unique drawing for each panel.
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, as applicable, 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. System Description:
 1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, 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 that 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 outpoints.
 - d. Operator workstation failure.
 - e. Server failure.
 - f. Gateway failure.
 - g. Network failure.
 - h. Controller failure.
 - i. Instrument failure.
 - j. Control damper actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner's Representative.
5. Description of testing plans and procedures.
6. Description of Owner training.
7. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
8. Schedule and design calculations for control dampers and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Face velocity at Project design and minimum airflow conditions.
 - c. Pressure drop across damper at Project design and minimum airflow conditions.
 - d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
 - e. Maximum close-off pressure.
 - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.
 - i. Actuator signal to control damper (on, close, or modulate).
 - j. Actuator position on loss of power.
 - k. Actuator position on loss of control signal.
9. Schedule and design calculations for selecting flow instruments.
 - a. Instrument flow range.
 - b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.
 - c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.
 - d. Pressure-differential loss across instrument at Project design flow conditions.
 - e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system.

1. In addition to items specified in Section 017823 "Operation and Maintenance Documents," include the following:
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
 - e. Operator's 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.
 - f. 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.

- g. Engineering, installation, and maintenance manuals that explain how to do the following:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
- h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- i. Backup copy of graphic files, programs, and databases on electronic media.
- j. List of recommended spare parts with part numbers and suppliers.
- k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- m. Licenses, guarantees, and warranty documents.
- n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- o. Owner training materials.

1.5 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.
- 4. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
- 5. Having full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing, and quality control.
 - d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
 - e. Owner operator training.

B. DDC System Provider Qualifications:

- 1. Authorized representative of, and trained by, DDC system manufacturer.
- 2. In-place facility located within 100 miles of Project.
- 3. Demonstrate past experience with installation of DDC system products being installed for period within three consecutive years before time of bid.
- 4. Demonstrate past experience on five projects of similar complexity, scope, and value.
- 5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
- 6. Service and maintenance staff assigned to support Project during warranty period.

7. Product parts inventory to support ongoing DDC system operation for a period of not less than five years after Substantial Completion.
8. DDC system manufacturer's backing to take over execution of the Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.6 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
 1. Adjust, repair, or replace failures at no additional cost or reduction in service to Owner.
 2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
 - a. Install updates only after receiving Owner's Representative written authorization.
 3. Perform warranty service during normal business hours and commence within 8 hours of Owner's warranty service request.
 4. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Alerton Inc.
 2. Automated Logic Corporation.
 3. Honeywell International Inc.
 4. Johnson Controls, Inc.
 5. Siemens Industry, Inc., Building Technologies Division.

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 consisting of high speed peer-to-peer network of distributed DDC controllers, operator interfaces, and software.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

- A. DDC system to be web compatible.

1. Web-Compatible Access to DDC System:

- a. Workstation and/or server to perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
- b. DDC system to support web browser access to building data. Operator using a standard web browser is able to access control graphics and change adjustable set points.
- c. Password-protected web access.

2.4 PERFORMANCE REQUIREMENTS

A. DDC System Speed:

1. Response Time of Connected I/O:

- a. Update AI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
- b. Update BI point values connected to DDC system at least every five seconds for use by DDC controllers. Points used globally to also comply with this requirement.
- c. AO points connected to DDC system to begin to respond to controller output commands within two seconds. Global commands to also comply with this requirement.
- d. BO point values connected to DDC system to respond to controller output commands within two seconds. Global commands to also comply with this requirement.

2. Display of Connected I/O:

- a. Update and display analog point COV connected to DDC system at least every five seconds for use by operator.
- b. Update and display binary point COV connected to DDC system at least every five seconds for use by operator.
- c. Update and display alarms of analog and digital points connected to DDC system within thirty seconds of activation or change of state.
- d. Update graphic display refresh within four seconds.
- e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations to not exceed graphic refresh rate indicated.

- B. Network Bandwidth: Design each network of DDC system to include spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.

C. DDC System Data Storage:

Verify with client on their intended time frame to keep historical data (think trends). This helps with troubleshooting the project should problems arise after construction.

1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends, and other information indicated.
 2. Local Storage:
 - a. Provide server with data storage indicated. Server(s) to use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.
- D. DDC Data Access:
1. When logged into the system, operator able to also interact with any DDC controllers connected to DDC system as required for functional operation of DDC system.
 2. Use 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.
- E. Future Expandability:
1. DDC system size is expandable to an ultimate capacity of at least 1.25 times total I/O points indicated.
 2. Design and install system networks to achieve ultimate capacity with only addition of DDC controllers, I/O, and associated wiring and cable. Design and install initial network infrastructure to support ultimate capacity without having to remove and replace portions of network installation.
 3. Operator interfaces installed initially do not require hardware and software additions and revisions for system when operating at ultimate capacity.
- F. Input Point Values Displayed Accuracy: Meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.
1. Energy:
 - a. Thermal: Within 5 percent of reading.
 - b. Electric Power: Within 1 percent of reading.
 - c. Requirements indicated on Drawings for meters not supplied by utility.
 2. Flow:
 - a. Air: Within 5 percent of design flow rate.
 - b. Air (Terminal Units): Within percent of design flow rate.
 - c. Natural Gas: Within 2 percent of design flow rate.
 3. Gas:
 - a. Carbon Dioxide: Within 50 ppm.
 - b. Refrigerant: Within 5 percent of reading.
 - c. VOCs: Within 5 percent of reading.
 4. Moisture (Relative Humidity):
 - a. Air: Within 5 percent RH.

- b. Space: Within 5 percent RH.
 - c. Outdoor: Within 5 percent RH.
 - 5. Pressure:
 - a. Air, Ducts and Equipment: 1 percent of instrument range.
 - b. Space: Within 1 percent of instrument range.
 - 6. Speed: Within 10 percent of reading.
 - 7. Temperature, Dew Point:
 - a. Air: Within 1 deg F.
 - b. Space: Within 1 deg F.
 - c. Outdoor: Within 3 deg F.
 - 8. Temperature, Dry Bulb:
 - a. Air: Within 1 deg F.
 - b. Space: Within 1 deg F.
 - c. Outdoor: Within 2 deg F.
 - d. Temperature Difference: Within 0.1 deg F.
 - e. Other Temperatures Not Indicated: Within 1 deg F.
 - 9. Temperature, Wet Bulb:
 - a. Air: Within 1 deg F.
 - b. Space: Within 1 deg F.
 - c. Outdoor: Within 2 deg F.
 - 10. Vibration: Within 5 percent of reading.
- G. Precision of I/O Reported Values: Values reported in database and displayed to have following precision:
- 1. Current:
 - a. Milliamperes: Nearest 1/100th of a milliampere.
 - b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A 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. Natural Gas (Usage): Nearest 1/10th of a unit (cubic feet, MCF, therm) up to 100 units; nearest unit for above 100 units.
 - c. Thermal, Rate:

- 1) Heating: For British thermal units per hour, nearest British thermal unit per hour 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.
 - d. Thermal, Usage:
 - 1) Heating: For British thermal unit, nearest British thermal unit 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 1/10th of a cubic feet per minute through 100 cfm; nearest cubic feet per minute between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
 - b. Natural Gas: Nearest 1/10th of a cubic feet per hour through 100 cfh; nearest cubic feet per hour between 100 and 1000 cfh; nearest 10 cfh between 1000 and 10,000 cfh; nearest 100 cfh above 10,000 cfh.
 4. Gas:
 - a. Carbon Dioxide (ppm): Nearest ppm.
 - b. Refrigerant (ppm): Nearest ppm.
 - c. Volatile Organic Compounds (ppm): Nearest ppm
 5. Moisture (Relative Humidity):
 - a. Relative Humidity (Percentage): Nearest 1 percent.
 6. Speed:
 - a. Rotation (rpm): Nearest 1 rpm.
 - b. Velocity: Nearest 1/10th of feet per minute through 100 fpm; nearest feet per minute between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.
 7. Position, Dampers (Percentage Open): Nearest 1 percent.
 8. Pressure:
 - a. Air, Ducts and Equipment: Nearest 1/10th of an inch water closet.
 - b. Space: Nearest 1/100th of an inch water closet.
 9. Temperature:
 - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
 - b. Outdoor: Nearest degree.
 - c. Space: Nearest 1/10th of a degree.

10. Vibration: Nearest 1/10th of an inch per second.
11. Voltage: Nearest 1/10 V up to 100 V; nearest volt above 100 V.

H. Environmental Conditions for Controllers, Gateways, and Routers, Instruments, and Actuators:

1. Products to 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 to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.
2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:
 - a. Outdoors, Protected: Type 3 or Type 12.
 - b. Outdoors, Unprotected: Type 4 or Type 4X.
 - c. Indoors, Heated with Filtered Ventilation: Type 1 or Type 2.
 - d. Indoors, Heated with Non-Filtered Ventilation: Type 2 or Type 12.
 - e. Indoors, Heated and Air-Conditioned: Type 1.
 - f. Mechanical Equipment Rooms:
 - 1) Air-Moving Equipment Rooms: Type 1, Type 2 or Type 12.
 - g. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2, Type or Type 12.
 - h. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4 or Type 4X.

I. 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 C62.41.1 and IEEE C62.41.2.
 - 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-microsecond waveform with a peak voltage of 1500 V and a peak current of 60 A.
 - 2) 8-by-20-microsecond 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 are as follows:

- 1) At 85 percent load, output voltage to 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 to not deviate by more than 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 to not exceed 3 percent at full load.
3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products to not fail due to ground fault condition.

2.5 SYSTEM ARCHITECTURE

- A. Provide dedicated DDC system LANs that are not shared with other building systems and tenant data and communication networks.
- B. Provide modular system architecture with inherent ability to expand to no less than 1.5 times system size indicated with no impact to performance indicated.
- C. Configure architecture to minimize need to remove and replace existing network equipment for system expansion.
- D. Make number of LANs and associated communication transparent to operator. Configure all I/O points residing on any LAN to be capable of global sharing between all system LANs.
- E. Design system to eliminate dependence on any single device for system alarm reporting and control execution. Design each controller to operate independently by performing own control, alarm management, and historical data collection.
- F. Special Network Architecture Requirements:
 1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling-system air-handling unit(s). Basically, create DDC system LAN that aligns with air-handling system being controlled.

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. Desktop and portable workstation with hardwired connection through LAN port.
 2. Portable operator terminal with hardwired connection through LAN port.
 3. Portable operator workstation with wireless connection through LAN router.
 4. Mobile device and application with secured wireless connection through LAN router or cellular data service.
 5. Remote connection through web access.

- B. Make access to system, regardless of operator means used, transparent to operator.
- C. Desktop Workstations:
 - 1. Able to communicate with any device located on any DDC system LAN.
- D. Portable Workstations:
 - 1. Able to communicate with any device located on any DDC system LAN.
 - 2. Connect to DDC system LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
 - 3. Connect to system through a wireless router connected to Level 1 LAN.
 - 4. Connect to system through a cellular broadband data service.
 - 5. Portable workstation able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
 - 6. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
 - 7. Have dynamic graphic displays that are identical to desktop workstations.
- 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.

2.7 NETWORKS

- A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:
 - 1. IP.
 - 2. ISO/IEC/IEEE 8802-3, Ethernet.
- B. Acceptable networks for connecting programmable application controllers include the following:
 - 1. BACnet IP.
 - 2. IP.
 - 3. ISO/IEC/IEEE 8802-3, Ethernet.
- C. Acceptable networks for connecting application-specific controllers include the following:
 - 1. BACnet MS/TP.
 - 2. BACnet IP.
 - 3. Modbus TCP/IP.
 - 4. Modbus RTU.

2.8 NETWORK COMMUNICATION PROTOCOL

- A. Use network communication protocol(s) that are open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. Use ASHRAE 135 communication protocol as sole and native protocol used throughout entire DDC system.
2. DDC system to not require use of gateways except to integrate HVAC equipment and other building systems and equipment; not required to use ASHRAE 135 communication protocol.
3. If used, gateways to connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Use operator workstations, controllers, and other network devices that are tested and listed by BTL.

C. Industry Standard Protocols:

1. Use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
 - a. ASHRAE 135.
 - b. Modbus Application Protocol Specification V1.1b3.
2. Operator workstations and network controllers are to communicate through ASHRAE 135 protocol.
3. Provide portions of DDC system networks using ASHRAE 135 communication protocol as an open implementation of network devices complying with ASHRAE 135. Use network devices that are tested and listed by BTL.
4. Provide portions of DDC system networks using Modbus Application Protocol Specification V1.1b3 communication protocol as an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b3.
5. Use gateways to connect networks and network devices with different protocols.

2.9 DESKTOP WORKSTATIONS

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

1. Dell Technologies Inc.
2. HP Inc.
3. Lenovo Holding Co., Inc.; Lenovo Group Ltd.

B. Description: A tower or all-in-one computer designed for normal use at a single, semipermanent location.

C. Performance Requirements:

1. May dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.

D. Personal Computer:

The Server/Workstation must meet the following minimum requirements.

1. Server Hardware Requirements

a. The Server shall meet the following minimum requirements:

- 1) Performance Target: The ability to handle 2000 MB/s of throughput and 180,000 IOPS.
 - a) Single core clock speed is paramount for BAS software platform running on the server.
 - b) This is not a minimum but rather benchmark target that will help for comparing different systems and builds to ensure the system will perform well under heavy loads. The closer the system can get to this level of performance the better. Depending on the size and configuration of the station a lower benchmark will be suitable.
- 2) Processor Base Frequency: 3 GHz processor base frequency
- 3) Processor Recommendations: Intel Quad Core Xeon or Core i7 Quad Core Processor (9th Gen or newer) operating at 3 GHz processor base frequency (AMD should be equivalent in single core performance to the Intel processor recommendation)
- 4) RAM: 32 GB DDR4 ECC RAM
- 5) Storage: 1TB SSD/NVMe
 - a) Should be server grade (Extended Write) SSD/NVMe
 - b) SSD/NVMe is preferred over mechanical drives. EC-Net performs frequent reads and writes to storage and depending on configuration can have a considerable number of files open. The speed, throughput and latency of storage is one of the most important factors in station performance.
- 6) Operating System and Support: Latest Windows 64-bit operating system (Windows 10 Pro or Windows Server 2019) and VM support
- 7) Security Certificate: Authorized TLS Certificate and Key
- 8) Internet Browser: Google Chrome, Microsoft Internet Explorer
- 9) Network Interface Cards: Multiple Gigabit Ethernet adapter network interface cards (minimum of 2 - ideally capable of port trunking, but not necessary)

b. The servers shall support all network/building controllers, operator workstations, and 3rd party mechanical / electrical systems connected to the Facility Management Control / Building Automation System Local Area Network.

c. Acceptable Manufacturers are:

- 1) Dell
- 2) HP (Hewlett Packard)

2. Workstation Hardware Requirements

a. The Workstation shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 8 GB RAM, and a 500GB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), Microsoft Office programs, VM support, an ethernet adapter (10/100MB with RJ45 connector), 32X CD-ROM drive, and 2-USB ports.

- b. A minimum 21", HDMI, DVI-D video interfaces, minimum 1024 x 768 resolution, 4x3 Widescreen, LED color monitor with a minimum 60 Hz refresh rate shall also be included.
- c. A mouse and keyboard shall be provided.
- d. Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.
- e. Workstation(s) should be loaded with Programming Tools
- f. Acceptable Manufacturers are:
 - 1) Dell
 - 2) Lenovo
 - 3) HP (Hewlett Packard)

2.10 PORTABLE WORKSTATIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dell Technologies Inc.
 - 2. HP Inc.
 - 3. Lenovo Holding Co., Inc.; Lenovo Group Ltd.
- B. Description: A self-contained computer designed to allow for normal use in different locations and conditions.
- C. Portable Workstation Requirements: Portable Workstation shall adhere to the following minimum requirements: the latest generation Intel Core i3 processor, 8 GB RAM, and a 256 GB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), Microsoft Office programs, VM support, an ethernet adapter (10/100MB with RJ45 connector), 2-USB ports, and 15" LED display capable of as a minimum 1024 x 768 resolution.
- D. Portable Workstation(s) should be loaded with Programming Tools
- E. Acceptable Manufacturers are:
 - 1. Dell
 - 2. Lenovo
 - 3. HP (Hewlett Packard)
- F. Accessories:
 - 1. Nylon carrying case.
 - 2. Docking station.
 - 3. Mobile broadband card.
 - 4. Wireless optical mouse.
 - 5. TB portable hard drive.
 - 6. Light-sensitive web cam and noise-cancelling digital array microphone.
 - 7. Category 6a patch cable. Minimum cable length is to be 3 feet.
 - 8. HDMI cable. Minimum cable length is to be 3 feet.

2.11 PORTABLE OPERATOR TERMINALS

- A. Description: Handheld device with integral keypad or touch screen operator interface.
- B. Display: Multiple lines of text display for use in operator interaction with DDC system.
- C. Cable: Flexible cable, at least 36 inches long, with a plug-in jack for connection to DDC controllers, network ports, or instruments with an integral LAN port. As an alternative to hardwired connection, POTs may be accessible to DDC controllers through a wireless network connection.
- D. Power POTs through network connection.
- E. Connection of POTs to DDC system to not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or preclude central initiated commands and system modification.
- F. POTs to give operator ability to do the following:
 - 1. Display and monitor BI point status.
 - 2. Change BO point set point (on or off, open or closed).
 - 3. Display and monitor analog point values.
 - 4. Change analog control set points.
 - 5. Command a setting of AO point.
 - 6. Display and monitor I/O point in alarm.
 - 7. Add a new or delete an existing I/O point.
 - 8. Enable and disable I/O points, initiators, and programs.
 - 9. Display and change time and date.
 - 10. Display and change time schedules.
 - 11. Display and change run-time counters and run-time limits.
 - 12. Display and change time and event initiation.
 - 13. Display and change control application and DDC parameters.
 - 14. Display and change programmable offset values.
 - 15. Access DDC controller initialization routines and diagnostics.

2.12 SYSTEM SOFTWARE

- A. System Software Minimum Requirements:
 - 1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
 - 2. Operating system capable of operating Microsoft Windows applications.
 - 3. Database management software to manage all data on an integrated and non-redundant basis. Additions and deletions to database are to 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 to manage and control multiple network communications to provide exchange of global information and execution of global programs.
 - 5. Operator interface software to 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 to schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Make operator sign-off a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
2. Make automatic sign-off period programmable from one to 60 minutes in one-minute increments on a per operator basis.
3. Record operator sign-on and sign-off activity and send to printer.
4. Security Access:
 - a. Use password control for operator access to DDC system.
 - b. Assign an alphanumeric password (field assignable) to each operator.
 - c. Grant operators access to DDC system by entry of proper password.
 - d. Use same operator password regardless of which computer or other operator interface means are used.
 - e. Automatically update additions or changes made to passwords.
 - f. Assign each operator an access level to restrict access to data and functions the operator is capable of performing.
 - g. Provide software with at least five access levels.
 - h. Assign each menu item 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.
 - i. Display menu items to operator with those capable of access highlighted. Make menu and operator access level assignments online programmable and under password control.
5. Operators 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 disc 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 weekly schedules.
 - 8) List holiday programming.
 - 9) 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. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five 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.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface is to use a pointing device with pull-down or penetrating menus, color, and animation to facilitate operator understanding of system.
3. Make descriptors for graphics, points, alarms, and such modifiable through operator's workstation under password control.
4. Make graphic displays online user definable and modifiable using the hardware and software provided.
5. Make data displayed within a graphic assignable regardless of physical hardware address, communication, or point type.
6. Make graphics online programmable and under password control.
7. Make points assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
8. Graphics to also contain software points.
9. Penetration within a graphic hierarchy is to display each graphic name as graphics are selected to facilitate operator understanding.
10. Provide a back-trace feature to permit operator to move upward in the hierarchy using a pointing device. Back trace to 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.
11. Display operator accessed data on the monitor.
12. Provide operator with ability to select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Display defined and linked graphic below that selection.
13. Include operator with means to directly access graphics without going through penetration path.
14. Make dynamic data assignable to graphics.
15. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
16. Use color, rotation, or other highly visible means, to denote status and alarm states. Make colors variable for each class of points, as chosen by operator.
17. Provide dynamic points with operator adjustable update rates on a per point basis from one second to over a minute.
18. For operators with appropriate privilege, command points directly from display using pointing device.

- a. For an analog command point such as set point, display current conditions and limits so operator can position new set point using pointing device.
 - b. For a digital command point such as valve position, show valve in current state such as open or closed so operator could select alternative position using pointing device.
 - c. Include a keyboard equivalent for those operators with that preference.
19. Give operator ability 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 allows real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
20. Help Features:
 - a. Online context-sensitive help utility to facilitate operator training and understanding.
 - b. Bridge to further explanation of selected keywords and contain text and graphics to clarify system operation.
 - 1) If help feature does not have ability to bridge on keywords for more information, provide a complete set of user manuals in an indexed word-processing program, which runs concurrently with operating system software.
 - c. Available for Every Menu Item:
 - 1) Index items for each system menu item.
- 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 with point identification, set point and dynamic value indication, and sequence of operation.
 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. Alarm Handling Software:
 1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers.

2. Include first in, first out handling of alarms in accordance with alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Make alarm handling active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display is to 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-5561."
 - d. Include extended message capability to allow assignment and printing of extended action messages. Capability is to be operator programmable and assignable on a per point basis.
5. Direct alarms to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Ability to send email alarm messages to designated operators.
7. Ability to send end email, page, text, and voice messages to designated operators for critical alarms.
8. Categorize and process alarms 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 make an audible alarm sound and 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) Configure so each new alarm received makes an audible alarm sound that are silenced by "acknowledging" alarm or by pressing a "silence" key.
 - 3) Make acknowledgement of queued alarms either on an individual basis or through a multiple alarm acknowledgement.
 - 4) Print alarms returning to normal condition without an audible alarm 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.

9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.

F. Reports and Logs:

1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
2. Setup each report so data content, format, interval, and date are operator definable.
3. Sample and store report data on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation or server for historical reporting.
4. Make it possible for operators to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Store reports and logs on workstations and/or servers hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Make reports and logs readily printable and set to be print either on operator command or at a specific time each day.

G. Standard Reports: Provide standard DDC system reports with operator ability 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.

H. Custom Reports: Operator able to easily define and prepare any system data into a daily, weekly, monthly, annual, or other historical report. Reports to include a title with time and date stamp.

I. Standard Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Associate trends into groups, and setup a trend report for each group.
3. Store trends 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's Representative.
5. Make trend intervals operator selectable from 10 seconds up to 60 minutes. Make minimum number of consecutive trend values stored at one time 100 per variable.
6. When drive storage memory is full, overwrite oldest data with most recent data.
7. Make archived and real-time trend data available for viewing numerically and graphically by operators.

J. Custom Trends: Operator-definable custom trend log for any I/O point in DDC system.

1. Include each trend with interval, start time, and stop time.
2. Sample and store data on DDC controller, within reaching 75 percent storage limits of DDC controller, and then uploaded to archive on workstation or server hard drives.
3. Make data retrievable for use in spreadsheets and standard database programs.

K. 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.
 - a. Graphic Based: Use a library of function blocks made from preprogrammed code designed for DDC control systems.
 - 1) Assemble function blocks with interconnection lines that represent to control sequence in a flowchart.
 - 2) Make programming tools viewable in real time to show present values and logical results of each function block.
 - b. Menu Based: Done by entering parameters, definitions, conditions, requirements, and constraints.
 - c. Line by Line and Text Based: Programming is to 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.
3. 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.

2.13 ANALYTICS SOFTWARE

A. Scope: Incorporate analytics software into DDC System:

1. Licensing, without Recurring Cost: No re-occurring cost for licensing and subscriptions.
2. Licensing: With or without re-occurring cost for licensing and subscriptions.
 - a. For products with re-occurring costs, provide incremental costs broken down over a 10-year operating period that begins at Substantial Completion.
 - b. Setup service agreements direct to Owner.
3. Purpose: Analyze energy and operational data to identify faults and opportunities for improved performance and reduced energy use.
4. Verification: Verify that HVAC systems and associated sequence of operations are executing as specified or as described on Drawings, through the analysis of energy and operational data, identification of faults showing where control sequences are not functioning as prescribed, and identification of opportunities for improved performance in the operation of systems.

B. Use during Project Life:

1. During Construction: Use for verification of performance during startup, commissioning, and final acceptance of DDC system.

2. During Warranty Period: Use for continuous operational tuning of DDC system and verification of operation and designed to identify warranty issues preemptively, thus reducing failures and potential down time.
3. After Warranty Period: Use to diagnose ongoing operational degradation and for Owner to perform continuous monitoring-based commissioning.

C. Minimum Features and Capabilities:

1. Operating Systems: Current version of Windows-based operating systems.
2. Time Series Database: Database technology, designed for efficient storage and analysis of large volumes of time series data, using tagging to model and describe data; supports an open-source tagging standard.
3. Data Import: Ability to accept and normalize data from a variety of sources including SQL compatible databases, CSV format files, XML format files or web services, and other EDI techniques. Once imported, software is to provide a unified data format to enable analytics algorithms to identify patterns across different data sets.
4. Open Interfaces: Open, REST-based APIs to enable integration with third-party software applications. Open APIs are to enable data to be entered/imported into database, exported from database, posting of analytic queries, and output of analytic results. APIs are to be fully documented and available as part of standard product.
5. Host: Local deployed on DDC system network.
6. Weather Data Service: Built-in worldwide weather service providing weather data including, but not limited to, the following:
 - a. Current temperature.
 - b. High temperature for the day.
 - c. Low temperature for the day.
 - d. Sunrise and sunset times.
 - e. Relative humidity.
 - f. Degree days (heating and cooling with adjustable balance point value).
 - g. Seven-day forecast.
 - h. Historical weather data extending back at least one year.
7. Email Notification: Automatic notification of detected issues via email including, but not limited to, the following:
 - a. Immediate notification of detected issues.
 - b. Daily digest or summary of detected issues.
 - c. Ability to delineate which notifications are sent to which recipients down to the level of specifying individual issues sent to individual recipients.

D. Hardware Requirements:

1. Host on a server in a virtual environment complying with Owner's security requirements.
2. Comply with standard software and hardware profiles required by Owner.

E. Analytic Rules:

1. Custom Rule Development: Develop customized rules and algorithms tailored to operational needs and characteristics of individual facilities and needs of monitoring and verification project and fault-detection requirements of Project without depending on manufacturer for rule development. Provide tools for user development and full documentation.

2. Standard Analytic Functions: Library of standard analytic functions is to use these standard analytic functions as elements to build custom analytic rules for specific needs of individual facilities.
3. Existing library of not less than 200 standard analytic rules written for applications similar to those required for this Project.

F. Reporting:

1. Standard Views of Analytic Results: Standard views to present analytic results, automatically generated when issues are found by analytic rules including, but not limited to, the following:
 - a. Rules violations across a portfolio of sites, rules violations per site, including time, date, and duration of all violations.
 - b. Ability to assign cost relationships to rule logic to provide cost per violation.
 - c. Standard filters to enable operator to easily look at rule violations by site, data, and violation type for any selected date or date range.
 - d. Automatic calculation and presentation of Key Performance Indicators (KPIs) and to define custom KPIs as needed.
2. Custom Views of Analytic Results:
 - a. Any standard system view is to be able to be saved as a custom report including its configuration criteria, e.g., time range, sites, rule violations, or other configuration options as applicable to standard system view.
 - b. Created by making queries against the database and saving the query as a saved report executed by single mouse click.
 - c. Export: Support report views export into CSV, Excel, XML, and HTML format, accomplished in a couple of mouse clicks.

G. Energy-Specific Reporting and Information Presentation Tools:

1. Greenhouse Gas Analysis: Energy/carbon dioxide relationships; easily changed and added without involvement of software manufacturer.
2. Energy Baseline: Quantify and define energy consumption and demand baselines (including weather normalization metrics) and compare actual and forecasted energy demand and consumption against those baselines.
3. Benchmarking: Multisite benchmarking to compare energy consumption and demand profiles and baselines across all buildings within Owner's portfolio.
4. Forecasting: Forecast near-future loads by using historic trends and forecasted weather data.
5. Financial Analysis: Calculate costs based on energy consumption and demand and energy costs and associate costs with any faults discovered by any analytic function and perform model- or tariff-based calculations to determine costs.
6. Tracking of Key Performance Indicators: Definition and tracking of user-defined key performance indicators/operational metrics. Examples include energy demand and consumption normalized for area and weather, peak demand, and consumption shown with minimum and maximum ranges across any user-selectable period.
7. Correlation of Energy Use with Equipment Operation: Automatically present views showing correlation between energy demand and consumption and operation of loads associated with that usage. Include the following:
 - a. All submeters and virtual meters.
 - b. Weather data as a selectable item.

H. Implementation:

1. Apply analytic rules to all HVAC systems and equipment monitored and controlled by DDC system. To extent available, use a subset of rules in existing rules library.
2. Implement rules to aid in determining proper operation of any HVAC system with a programmed sequence of operation.
3. Generate reports to aid in verification of proper operation during initial system startup and commissioning to supplement (not replace) commissioning agent reports.
4. Prepare quarterly reports summarizing faults detected and KPIs, including recommended corrective action.

I. Training:

1. Train Owner' personnel sufficiently to use software without need for external support.

2.14 OFFICE APPLICATION SOFTWARE

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

1. Microsoft Corporation.

B. Include current version of office application software at time of Substantial Completion.

C. Office application software package to include multiple separate applications and use a common platform for all applications.

1. Database.
2. Email.
3. Presentation.
4. Publishing.
5. Spreadsheet.
6. Word processing.

2.15 ASHRAE 135 GATEWAYS

A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, and variable-speed drives.

B. Include gateways to connect BACnet to legacy systems where indicated, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment.

C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.

D. Gateway Minimum Requirements:

1. Read and view all readable object properties on non-BACnet network to BACnet network, and vice versa, where applicable.
2. Write to all writable object properties on non-BACnet network from BACnet network, and vice versa, where applicable.

3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet, and vice versa.
4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs in accordance with ASHRAE 135.
5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media with ability to modify, download, backup, and restore gateway configuration.

2.16 DDC CONTROLLERS

- A. DDC system consisting of a combination of network controllers, programmable application controllers, and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers to perform monitoring, control, energy optimization, and other requirements indicated.
- C. DDC controllers are to use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller is capable of full and complete operation as a completely independent unit and as a part of DDC system wide distributed network.
- E. Environment Requirements:
 1. Controller hardware suitable for anticipated ambient conditions.
 2. Controllers located in conditioned space rated for operation at 32 to 120 deg F
 3. Controllers located outdoors rated for operation at 40 to 150 deg F.
- F. Power and Noise Immunity:
 1. Operate controller at 90 to 110 percent of nominal voltage rating and perform an orderly shutdown below 80 percent of nominal voltage.
 2. Protect 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.
- G. I/O Point Interface:
 1. Connect hardwired I/O points to network, programmable application, and application-specific controllers.
 2. Protect I/O points so shorting of point to itself, to another point, or to ground will not damage controller.
 3. Protect I/O points from voltage up to 24 V of any duration so that contact will not damage controller.
 4. Als:
 - a. Include monitoring of low-voltage (0 to 10 V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
 - b. Compatible with, and field configurable to, sensor and transmitters installed.
 - c. Capable of being individually calibrated for zero and span.

- d. Incorporate common-mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
- 5. AOs:
 - a. Output signals range of 4 to 20 mA dc or 0 to 10 V dc as required to include proper control of output device.
 - b. Capable of being individually calibrated for zero and span.
 - c. Drift is to be not greater than 0.4 percent of range per year.
- 6. BIs:
 - a. Accept contact closures and ignore transients of less than 5 ms duration.
 - b. Isolate and protect against an applied steady-state voltage of up to 180 V ac peak.
 - c. Include a wetting current of at least 12 mA to be compatible with commonly available control devices and protected against effects of contact bounce and noise.
 - d. Sense "dry contact" closure without external power (other than that provided by controller) being applied.
 - e. Pulse accumulation input points complying with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Include buffer to totalize pulses. Pulse accumulator is to accept rates of at least 20 pulses per second. Reset the totalized value to zero on operator's command.
- 7. BOs:
 - a. Include relay contact closures or triac outputs for momentary and maintained operation of output devices.
 - 1) Relay contact closures to have a minimum duration of 0.1 second and at least 180 V of isolation.
 - 2) Include electromagnetic interference suppression on all output lines to limit transients to non-damaging levels.
 - 3) Minimum contact rating to be 1 A at 24 V ac.
 - 4) Triac outputs to have at least 180 V of isolation and minimum contact rating of 1 A at 24 V ac.
 - b. Include BOs with two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
 - c. BOs to be selectable for either normally open or normally closed operation.
 - d. Include tristate outputs (two coordinated BOs) for control of three-point, floating-type electronic actuators without feedback.
 - e. Limit use of three-point floating devices to VAV terminal unit control applications. Control algorithms to operate actuator to one end of its stroke once every 12 hours for verification of operator tracking.

2.17 NETWORK CONTROLLERS

A. General:

- 1. Include adequate number of controllers to achieve performance indicated.
- 2. Provide one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.

3. Include enough memory to support its operating system, database, and programming requirements with spare memory indicated.
4. Share data between networked controllers and other network devices.
5. Operating system of controller to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Include network controllers with a real-time clock.
7. Controller to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller is to assume a predetermined failure mode and generate an alarm notification.
8. Make controllers fully programmable.

B. Communication:

1. Network controllers communicate with other devices on DDC system.
2. Network controller to also perform routing if connected to network of programmable application controllers and application-specific controllers.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to desktop operator's workstation, portable operator's workstation, POT, or mobile device.

2.18 PROGRAMMABLE APPLICATION CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide enough memory to support its operating system, database, and programming requirements with spare memory indicated.
3. Share data between networked controllers and other network devices.
4. Include controller with operating system to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Include controllers with a real-time clock.
6. Controller is to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller assumes a predetermined failure mode and generates an alarm notification.
7. Fully programmable.

B. Communication:

1. Programmable application controllers are to communicate with other devices on network.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to desktop workstation, portable operator's workstation, POT, or mobile device.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.

2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain BIOS and programming information in event of power loss for at least 72 hours.

2.19 APPLICATION-SPECIFIC CONTROLLERS

- A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment or system. 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 continued control functions without being connected to network.
 2. Share data between networked controllers and other network devices.
- B. Communication: Application-specific controllers are to communicate with other application-specific controllers and devices on network, and to programmable application controllers and network controllers.
- C. Operator Interface: Equip controllers with a service communications port for connection to desktop workstation, portable operator's workstation, POT, or mobile device. Connection is to extend to port on space temperature sensor that is connected to controller.
- D. Serviceability:
 1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
 2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 3. Use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.20 CONTROLLER SOFTWARE

- A. General:
 1. Software applications are to reside and operate in controllers. Edit applications through operator workstations.
 2. Identify I/O points by up to 30-character point name and up to 16-character point descriptor. Use same names throughout, including at operator workstations.
 3. Execute control functions within controllers using DDC algorithms.
 4. Configure controllers to use stored default values to ensure fail-safe operation. Use default values when there is a failure of a connected input instrument or loss of communication of a global point value.
- B. Security:
 1. Secure operator access using individual security passwords and user names.
 2. Passwords restrict operator to points, applications, and system functions as assigned by system manager.
 3. Record operator log-on and log-off attempts.

4. Protect from unauthorized use by automatically logging off after last keystroke. Make the delay time operator-definable.
- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule is to consist of the following:
 1. Weekly Schedules:
 - a. Include separate schedules for each day of week.
 - b. Each schedule should include 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. Place schedules on scheduling calendar with ability to repeated each year.
 - c. Operator able to define length of each holiday period.
- D. System Coordination:
 1. Include standard application for proper coordination of equipment.
 2. Include operator with a method of grouping together equipment based on function and location.
 3. Include groups that may be for use in scheduling and other applications.
- E. Binary Alarms:
 1. Set each binary point to alarm based on operator-specified state.
 2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
 1. Provide each analog object with both high and low alarm limits.
 2. Include capability to automatically and manually disable alarming.
- G. Alarm Reporting:
 1. Include ability for operators to determine action to be taken in event of an alarm.
 2. Route alarms to appropriate operator workstations based on time and other conditions.
 3. Include ability for alarms to start programs, print, be logged in event logs, generate custom messages, and display graphics.
- H. Remote Communication:

1. Include ability for system to notify operators by phone message, text message, and email in event of an alarm.
- I. Electric Power Demand Limiting:
 1. Monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
 2. Predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
 3. Accomplish demand reduction by the following means:
 - a. Reset air-handling-unit supply temperature set points.
 - b. Reset space temperature set points.
 - c. De-energize equipment based on priority.
 4. Base demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables on the means by which electric power service provider computes demand charges.
 5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
 6. Include means operator to make the following changes online:
 - a. Addition and deletion of loads controlled.
 - b. Changes in demand intervals.
 - c. Changes in demand limit for meter(s).
 - d. Maximum shutoff time for equipment.
 - e. Minimum shutoff time for equipment.
 - f. Select rotational or sequential shedding and restoring.
 - g. Shed and restore priority.
 7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly, and annual basis:
 - a. Total electric consumption.
 - b. Peak demand.
 - c. Date and time of peak demand.
 - d. Daily peak demand.
- J. Maintenance Management: Monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.
- K. Sequencing: Include application software based on sequences of operation indicated to properly sequence applicable HVAC equipment.
- L. Control Loops:
 1. Support any of the following control loops, as applicable to control required:
 - 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 to calculate a time-varying analog value used to position an output or stage a series of outputs.
 - 3) Make controlled variable, set point, and PID gains operator-selectable.
 - e. Adaptive (automatic tuning).
- M. Staggered Start: Prevent all controlled equipment from simultaneously restarting after a power outage. Make the order which equipment (or groups of equipment) is started, along with the time delay between starts, operator-selectable.
- N. Energy Calculations:
- 1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
 - 2. Include algorithm that calculates a sliding-window average (rolling average). Make algorithm flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
 - 3. Include algorithm that calculates a fixed-window average. Use a digital input signal to define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.
- O. Anti-Short Cycling:
- 1. Protect BO points from short cycling.
 - 2. Feature to allow minimum on-time and off-time to be selected.
- P. On and Off Control with Differential:
- 1. Include algorithm that allows BO to be cycled based on a controlled variable and set point.
 - 2. Use direct- or reverse-acting algorithm and incorporate an adjustable differential.
- Q. Run-Time Totalization:
- 1. Include software to totalize run-times for all BO points.
 - 2. Assign a high run-time alarm, if required, by operator.
- 2.21 ENCLOSURES
- A. General:
- 1. House each controller and associated control accessories in an enclosure. Enclosure is to 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. Freestanding enclosures maximum of 48 inches wide and 72 inches high.
 - 4. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.

5. Supply each enclosure with complete set of as-built schematics, tubing, and wiring diagrams and product literature located in pocket on inside of door.

B. Internal Arrangement:

1. Arrange internal layout of enclosure to group and protect electric, and electronic components associated with 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 spade lugs for stranded cable and wire.
7. Install maximum of two wires on each side of terminal.
8. Include enclosure field electric power supply with toggle-type switch located at entrance inside enclosure to disconnect power.
9. Include enclosure with line-voltage nominal 20 A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with 5 A circuit breaker.
10. Mount products within enclosure on removable internal panel(s).
11. Include products mounted in enclosures with nameplates (black letters on a white background). Nameplates are to have at least 1/4-inch high lettering.
12. Route tubing cable and wire located inside enclosure within a raceway with 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.

C. Wall-Mounted, NEMA 250, Type 1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line; a division of Eaton, Electrical Sector.
 - b. Hammond Mfg. Co. Inc.
 - c. Hoffman; brand of nVent Electrical plc.
 - d. Saginaw Control and Engineering.
2. NRTL listed in accordance with UL 50 or UL 50E.
3. Construct enclosure of steel, not less than the following:
 - a. Enclosure Size Less Than 24 Inches: 0.053 inch or 0.067 inch thick.
 - b. Enclosure Size 24 Inches and Larger: 0.067 inch or 0.093 inch thick.
4. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior Color: Manufacturer's standard.
 - b. Interior Color: Manufacturer's standard.
5. Hinged door full size of front face of enclosure and supported using the following:
 - a. Enclosures Sizes Less Than 36 Inches Tall: Multiple butt hinges.
 - b. Enclosures Sizes 36 Inches Tall and Larger: Continuous piano hinges.

6. Removable internal panel with white or gray 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.
 7. Internal panel mounting hardware, grounding hardware, and sealing washers.
 8. Grounding stud on enclosure body.
 9. Thermoplastic pocket on inside of door for record Drawings and Product Data.
- D. Wall-Mounted, NEMA 250, Types 4 and 12:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line; a division of Eaton, Electrical Sector.
 - b. Hammond Mfg. Co. Inc.
 - c. Hoffman; brand of nVent Electrical plc.
 - d. Saginaw Control and Engineering.
 2. NRTL listed in accordance with UL 508A.
 3. Seam and joints are continuously welded and ground smooth.
 4. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
 5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
 6. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
 7. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
 8. 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.
 9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior Color: Manufacturer's standard.
 - b. Interior Color: Manufacturer's standard.
 10. 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 (1200 mm) Tall: Three hinges.
 - c. Sizes Larger Than 48 Inches Tall: Four hinges.
 11. 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.
 12. Removable internal panel with white or gray 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.
 - 13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
 - 14. Grounding stud on enclosure body.
 - 15. Thermoplastic pocket on inside of door for record Drawings and Product Data.
- E. Wall-Mounted, NEMA 250, Type 4X-SS:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - b. Hammond Mfg. Co. Inc.
 - c. Hoffman; brand of nVent Electrical plc.
 - d. Saginaw Control and Engineering.
 - 2. NRTL listed in accordance with UL 508A.
 - 3. Seams and joints are continuously welded and ground smooth.
 - 4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
 - 5. Construct enclosure of Type 304 or Type 316L stainless steel, not less than the following:
 - a. Size Less Than 24 Inches: 0.053 inch thick.
 - b. Size 24 Inches and Larger: 0.067 inch thick.
 - 6. Outside body and door of enclosure with brushed No. 4 finish.
 - 7. 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 Than 48 Inches Tall: Four hinges.
 - 8. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, stainless steel handle with integral locking mechanism.
 - 9. Removable internal panel of 0.093-inch stainless steel.
 - 10. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
 - 11. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
 - 12. Include enclosure with stainless steel mounting brackets.
- F. Freestanding, NEMA 250, Type 1:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line; a division of Eaton, Electrical Sector.
 - b. Hammond Mfg. Co. Inc.
 - c. Hoffman; brand of nVent Electrical plc.
 - d. Saginaw Control and Engineering.
 - 2. NRTL listed in accordance with UL 508A.
 - 3. Seams and joints are continuously welded and ground smooth.

4. Externally formed body flange around perimeter of enclosure face.
5. Single-door enclosure sizes up to 84 inches tall by 36 inches wide.
6. Double-door enclosure sizes up to 84 inches tall by 72 inches wide.
7. Construct enclosure of steel, not less than 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: Manufacturer's standard.
 - b. Interior Color: Manufacturer's standard.
9. Corner-formed flush door, full size of enclosure face, supported using four concealed hinges with easily removable hinge pins.
10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
11. Doors with three-point (top, middle, and bottom) latch system with single heavy-duty handle and integral locking mechanism.
12. Removable back covers.
13. Removable solid steel internal panel, 0.093 inch thick, with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.
14. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
15. Grounding stud on enclosure body.
16. Thermoplastic pocket on inside of door for record Drawings and Product Data.
17. Nominal 4-inch- tall integral lifting base, not less than 0.123 inch thick, with predrilled holes for attachment to mounting surface.
18. Equip each top end of enclosure with lifting tabs, not less than 0.172 inch thick, or not less than two lifting eyes.
19. Internal rack-mount shelves and angles, as required by application.

G. Freestanding, NEMA 250, Types 4 and 12:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line; a division of Eaton, Electrical Sector.
 - b. Hammond Mfg. Co. Inc.
 - c. Hoffman; brand of nVent Electrical plc.
 - d. Saginaw Control and Engineering.
2. NRTL listed in accordance with UL 508A.
3. Seams and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face.
5. Type 12 Enclosure Sizes:
 - a. Single-door enclosure sizes up to 90 inches tall by 36 inches wide.
 - b. Double-door enclosure sizes up to 90 inches tall by 72 inches.
6. Type 4 Enclosure Sizes:
 - a. Single-door enclosure sizes up to 72 inches tall by 36 inches wide.
 - b. Double-door enclosure sizes larger than 36 inches wide.
7. Construct enclosure of steel, not less than 0.093 inch thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

- a. Exterior Color: Manufacturer's standard.
 - b. Interior Color: Manufacturer's standard.
 - 9. Corner-formed door with continuous perimeter oil-resistant gasket supported using continuous piano hinge full length of door.
 - 10. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty, oiltight handle with integral locking mechanism.
 - 11. Removable solid steel internal panel, 0.093 inch thick, with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - 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.
 - 15. Equip top of enclosure with no fewer than two lifting eyes.
 - 16. Internal rack-mount shelves and angles, as required by application.
- H. Freestanding, NEMA 250, Type 4X-SS:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - b. Hammond Mfg. Co. Inc.
 - c. Hoffman; brand of nVent Electrical plc.
 - d. Saginaw Control and Engineering.
 - 2. NRTL listed in accordance with UL 508A.
 - 3. Seams and joints are continuously welded and ground smooth.
 - 4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
 - 5. Construct enclosure of Type 304 or Type 316L stainless steel, not less than the following:
 - a. Size Less Than 24 Inches: 0.053 inch thick.
 - b. Size 24 Inches and Larger: 0.067 inch thick.
 - 6. Outside enclosure and door of enclosure with brushed No. 4 finish.
 - 7. Doors:
 - a. Single-door enclosure sizes up to 36 inches wide.
 - b. Double-door enclosure sizes larger than 36 inches wide.
 - c. Corner-formed door(s) with continuous perimeter oil-resistant gasket, full size of enclosure face, supported using continuous piano hinge full length of door.
 - d. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, Type 304 or Type 316L stainless steel handle with integral locking mechanism.
 - 8. Removable internal panel of 0.093-inch stainless steel.
 - 9. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
 - 10. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
 - 11. Include enclosure with stainless steel mounting brackets.
 - 12. Thermoplastic pocket on inside of door for record Drawings and Product Data.
 - 13. Equip top of enclosure with no fewer than two lifting eyes.
 - 14. Internal rack-mount shelves and angles, as required by application.
- I. Accessories:

1. Electric Heater:
 - a. Aluminum housing with brushed finish.
 - b. Thermostatic control with adjustable set point from 0 to 100 deg F.
 - c. Capacity: 100, 200, 400, and 800 W, as required by application.
 - d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.
2. Ventilation Fans, Filtered Intake, and Exhaust Grilles:
 - a. Number and size of fans, filters, and grilles, as required by application.
 - b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
 - c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
 - d. Thermostatic control with adjustable set point from 32 to 140 deg F.
 - e. Airflow Capacity at Zero Pressure:
 - 1) 4-Inch Fan: 100 cfm .
 - 2) 6-Inch Fan: 240 cfm.
 - 3) 10-Inch Fan: 560 cfm.
 - f. Maximum operating temperature of 158 deg F.
 - g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
 - h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
 - i. Dynamically balanced impellers molded from polycarbonate material.
 - j. Fan furnished with power cord and polarized plug for power connection.
 - k. Fan brackets, finger guards, and mounting hardware provided with fans to complete installation.
 - l. Removable Intake and Exhaust Grilles: ABS plastic or stainless steel, of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
 - m. Filters for NEMA 250, Type 1 Enclosures: Washable foam or aluminum, of size to match intake grille.
 - n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of size to match intake grille.
3. Air Conditioner:
 - a. Electric-powered, self-contained, air-conditioning unit specially designed for electrical enclosures to maintain temperature inside enclosure below ambient temperature outside enclosure.
 - b. Thermostatic control with adjustable set point from 60 to 120 deg F.
 - c. Enclosure side or top mounting with unit capacity, as required by application.
 - d. Designed for closed-loop cooling with continuous operation in ambient environments up to 125 deg F.
 - e. HFC refrigerant.
 - f. Reusable and washable air filter.
 - g. High-performance, industrial-grade, and high-efficiency fans.
 - h. Furnished with power cord and polarized plug for power connection.
 - i. Condensate management system with base pan side drain.
 - j. Mounting hardware, gaskets, mounting template, and instruction manual furnished with unit.

- k. Outdoor units equipped with head pressure control for low ambient operation, compressor heater, coated condenser coil, and thermostat.
- 4. Thermoelectric Humidifier:
 - a. ABS plastic enclosure.
 - b. Capacity of 8 oz. of water per 24 hours.
 - c. Built-in drain captures moisture and plastic hose directs moisture to outside enclosure through a drain.
 - d. Controlled to maintain enclosure relative humidity at adjustable set point.
 - e. Unit power supply is internally wired to enclosure electrical power source.
- 5. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:
 - a. 0.25-inch- thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
 - b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
 - c. Window kit to be factory or shop installed before shipment to Project.
- 6. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:
 - a. 0.125-inch- thick, polycarbonate window mounted in enclosure door material.
 - b. Window attached to door with screw fasteners and continuous strip of high-strength, double-sided tape around window perimeter.
 - c. Window kit is factory or shop installed before shipment to Project.
- 7. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:
 - a. 0.25-inch- thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
 - b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
 - c. Window kit to be factory or shop installed before shipment to Project.
- 8. Bar handle with keyed cylinder lock set.

2.22 RELAYS

A. General-Purpose Relays:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allen Bradley; by Rockwell Automation.
 - b. Eaton.
 - c. IDEC Corporation.
 - d. Omron Americas.
 - e. Siemens Industry, Inc., Building Technologies Division.
 - f. Square D; Schneider Electric USA.
- 2. NRTL listed.
- 3. Heavy-duty, electromechanical type; rated for at least 10 A at 250 V ac and 60 Hz.

4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with 8-pin octal or multiblade plug for DPDT relays and 11-pin octal or multiblade plug for three-pole double-throw relays.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a clear transparent polycarbonate dust-tight cover.
8. Include LED indication and push-to-test button to test manual operation of relay without power on coil.
9. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 20 ms or less.
 - d. Dropout Time: 20 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 10 percent of nominal rated voltage.
 - g. Power Consumption: 5 VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
10. Equip relays with coil transient suppression to limit transients to non-damaging levels.
11. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
12. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

B. Multifunction Time-Delay Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allen Bradley; by Rockwell Automation.
 - b. Eaton.
 - c. IDEC Corporation.
 - d. Omron Americas.
 - e. Siemens Industry, Inc., Building Technologies Division.
 - f. Square D; Schneider Electric USA.
2. NRTL listed.
3. Continuous-duty type, rated for at least 10 A at 240 V ac and 60 Hz.
4. Relay with up to 4 programmable functions to provide on/off delay, interval, and recycle timing functions.
5. Plug-in-style relay with either multi-pin or blade plug.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a dust-tight cover.
8. Include knob and dial scale for alternative digital interface for setting delay time.
9. Visual Status Indication: Power "On" status.
10. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
 - d. Repeatability: Within 2 percent.
 - e. Recycle Time: 45 > ms.
 - f. Minimum Pulse-Width Control: 50 ms.
 - g. Power Consumption: 5 VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

11. Equip relays with transient suppression to limit transients to non-damaging levels.
12. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
13. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

C. Latching Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allen Bradley; by Rockwell Automation.
 - b. Eaton.
 - c. IDEC Corporation.
 - d. Omron Americas.
 - e. Siemens Industry, Inc., Building Technologies Division.
 - f. Square D; Schneider Electric USA.
2. NRTL listed.
3. Continuous-duty type, rated for at least 10 A at 250 V ac and 60 Hz.
4. SPDT, DPDT, or three-pole double-throw, as required by control application.
5. Plug-in-style relay with either multi-pin or blade plug.
6. Construct contacts of silver, silver alloy, or gold.
7. Enclose relay in a clear transparent polycarbonate dust-tight cover.
8. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 20 ms or less.
 - d. Dropout Time: 20 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.
 - g. Power Consumption: 5 VA or less.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

D. Current Sensing Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. Functional Devices Inc.
 - c. NK Technologies.
 - d. Square D; Schneider Electric USA.
2. NRTL listed.
3. Monitors ac current.
4. Independent adjustable controls for pickup and dropout current.
5. Energized when supply voltage is present and current is above pickup setting.

6. De-energizes when monitored current is below dropout current.
7. Dropout current is adjustable from 50 to 95 percent of pickup current.
8. Visual indication of contact status.
9. Include current transformer, if required for application.
10. House current sensing relay and current transformer if required in its own enclosure. Use NEMA 250, Type 1 or Type 12 enclosure for indoors applications and NEMA 250, Type 4 or Type 4X for outdoor applications.

E. Combination On-Off Status Sensor and On-Off Control Relays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Functional Devices Inc.
 - b. Veris Industries.
2. Description:
 - a. On-off control and on-off 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 relay.
3. 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.
4. 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: As required by application.
 - c. Current Set Point: Fixed or adjustable, as required by application.
 - d. Current Sensor Output:
 - 1) Solid-state, SPDT contact rated for 30 V ac and dc and for 0.4 A.
 - 2) Solid-state, SPDT contact rated for 120 V ac and 1.0 A.
 - 3) Analog, 0 to 5 or 10 V dc.
 - 4) Analog, 4 to 20 mA, loop powered.
5. Relay: SPDT, continuous-duty coil; rated for 10-million mechanical cycles.
6. Enclosure: NEMA 250, Type 1 or Type 12 enclosure for indoor applications; NEMA 250, Type 4 or Type 4X enclosure for outdoor applications.

2.23 ELECTRICAL POWER DEVICES

A. Control Transformers:

1. Sizing Criteria: Size control transformers for total connected load, plus additional 25 percent of connected load for future spare capacity.
2. Transformer Minimum Capacity: 40 VA.

3. Protection: Provide transformers with both primary and secondary fuses. (Integral circuit breaker is acceptable in lieu of fuses.)
4. Enclosure: House control transformers in NEMA 250 enclosures, type as indicated in "Performance Requirements" Article for application.

B. DC Power Supplies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acopian Technical Company.
 - b. Emerson Electric Co., Automation Solutions.
 - c. IDEC Corporation.
 - d. Omron Americas.
2. Description: Linear or switched, regulated power supplies with ac input to one or multiple dc output(s).
 - a. Include both line and load regulation to ensure stable output.
 - b. To protect both power supply and load, include power supply with an automatic current limiting circuit.
3. Features:
 - a. Connection: Plug-in style suitable for mating with standard 8-pin octal socket. Include power supply with mating mounting socket.
 - b. Housing: Enclose circuitry in a housing.
 - c. Local Adjustment: Include screw adjustment on exterior of housing for dc voltage output.
 - d. Mounting: DIN rail.
 - e. Visual status indicator.
4. Performance:
 - a. Input Voltage: Nominally 120 V ac, 60 Hz.
 - b. Output Voltage: Nominally 24 V dc with plus or minus 1 V dc adjustment.
 - c. Output Current: Minimum 100 mA.
 - d. Load Regulation: Within 0.1 percent.
 - e. Line Regulation: Within 0.05 percent.
 - f. Stability: Within 0.1 percent of rated volts after warmup period.
 - g. Ripple: 1 mV rms.

2.24 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire Size: Minimum 14 AWG.
2. Conductors: 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor Insulation: 600 V, Type THWN or Type THHN, and 90 deg C in accordance with UL 83.
4. Conductor Insulation Colors: Black (hot), white (neutral), and green (ground).
5. Furnish on spools.

B. Single, Twisted-Shielded, Instrumentation Cable above 24 V:

1. Wire Size: Minimum 18 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor Insulation: Type THHN/THWN or Type TFN rating.
4. Conductor Insulation Colors:
 - a. Twisted Pair: Black and white.
 - b. Twisted Triad: Black, red, and white.
5. Shielding: 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.
6. Outer Jacket Insulation: 600 V, 90 deg C rating, and Type TC cable.
7. Furnish on spools.

C. Single, Twisted-Shielded, Instrumentation Cable 24 V and Less:

1. Wire Size: Minimum 22 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor Insulation: Nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Conductor Insulation Colors:
 - a. Twisted Pair: Black and white.
 - b. Twisted Triad: Black, red, and white.
5. Shielding: 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 300 V, 105 deg C rating, and Type PLTC cable.
7. Furnish on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Comply with following requirements for balanced twisted pair cable described in
 - a. Plenum rated.
 - b. Unique color that is different from other cables used on Project.

2.25 RACEWAYS

- A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power raceways and boxes.

2.26 ACCESSORIES

A. Pressure Electric Switches:

1. Description: Diaphragm-operated, snap-acting switch.
2. Performance:
 - a. Rating: Resistance loads at 120 V ac.

- b. Set Point: Adjustable from 3 to 20 psig.
 - c. Differential: Adjustable from 2 to 6 psig.
- 3. Body and Switch Housing: Metal.
- B. Control Damper Blade Limit Switches:
 - 1. Application: Sense positive open and/or closed position of damper blades.
 - 2. NEMA 250, Type 13, oiltight construction. Install in instrument enclosure where required for additional environmental protection.
 - 3. Arrange for mounting application, and to prevent "over-center" operation.

2.27 IDENTIFICATION

- A. 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 as follows:
 - a. Servers: Minimum of 0.5 inch high.
 - b. DDC Controllers: Minimum of 0.5 inch high.
 - c. Gateways: Minimum of 0.5 inch high.
 - d. Repeaters: Minimum of 0.5 inch high.
 - e. Enclosures: Minimum of 0.5 inch high.
 - f. Electrical Power Devices: Minimum of 0.25 inch high.
 - g. UPS units: Minimum of 0.5 inch high.
 - h. Accessories: Minimum of 0.25 inch high.
 - i. Instruments: Minimum of 0.25 inch high.
 - j. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
 - 3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded black with contrasting white center exposed by engraving through outer layer.
 - 4. 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.
- B. Raceway and Boxes:
 - 1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 2. Paint cover plates on junction boxes and conduit same color as tape banding for conduits. After painting, label cover plate "HVAC Controls" using engraved phenolic tag.
 - 3. For raceways housing air signal tubing, add phenolic tag labeled "HVAC Air Signal Tubing."
- C. Equipment Warning Labels:
 - 1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.

2. Lettering size at least 14-point type with white lettering on red background.
3. Warning label to 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 to be enclosed in a white line border. Edge of label is to extend at least 0.25 inch beyond white border.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Communication Interface to Equipment with Integral Controls:
 1. DDC system has communication interface with equipment having integral controls and having communication interface for remote monitoring or control.
 2. Equipment to Be Connected:
 - a. Variable refrigerant flow units specified in Section 238129 "Variable-Refrigerant-Flow HVAC Systems."
 - b. Fan-coil units specified in Section 238219 "Variable-Refrigerant-Flow HVAC Systems."
 - c. Dedicated Outdoor Air Units specified in Section 237433 "Dedicated Outdoor Air Units."
 - d. Air Terminal Units specified in Section 233600 "Air Terminal Units."

3.3 PREINSTALLATION INTEGRATION TESTING

- A. Perform the following pretesting of other systems and equipment integration with DDC system before field installation:

1. Test all communications in a controlled environment to ensure connectivity.
2. Load software and demonstrate functional compliance with each control sequence of operation indicated.
3. Using simulation, demonstrate compliance with sequences of operation and other requirements indicated including, but not limited to, the following:
 - a. HVAC equipment controlled through DDC system, such as air-handling units.
 - b. Equipment faults and system recovery with fault annunciation.
 - c. Analog and Boolean value alarming and annunciation.
4. Develop a method for testing interfaces before deployment.
5. Submit documentation supporting compliance upon request.

3.4 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified 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. Control dampers, which are specified in Section 230923.12 "Control Dampers."
 2. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."

3.5 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, tubing, piping wiring, and raceways.
- 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 Section 078413 "Through Penetration Firestop systems."
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."
- H. Welding Requirements:
 1. Restrict welding and burning to supports and bracing.
 2. No equipment is 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, is to be by inert-gas electric arc process and is to be performed by qualified welders in accordance with 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. 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. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

3.6 INSTALLATION OF WORKSTATIONS

- A. Desktop Workstation Installation:
1. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex, electrical power receptacle.
 2. Install DDC system software on workstation(s) and verify that software functions properly.
 3. Develop Project-specific graphics, trends, reports, logs, and historical database.
 4. Power workstation through a dedicated UPS unit. Locate UPS adjacent to workstation.
- B. Color Graphics Application:
1. Use system schematics indicated on Drawings as starting point to create graphics.
 2. Develop Project-specific library of symbols for representing system equipment and products.
 3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
 4. Submit sketch of graphic layout with description of all text for each graphic for Owner's Representative review before creating graphic using graphics software.
 5. Seek Owner's Representative input in graphics development once using graphics software.
 6. Make final editing on-site with Owner's Representative review and feedback.
 7. Refine graphics as necessary for Owner's Representative acceptance.
 8. On receiving Owner's Representative acceptance, print a PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

3.7 INSTALLATION OF SERVERS

- A. Install server(s) at location(s) indicated on Drawings.
- B. Install number of servers required to suit requirements indicated. Review Project requirements and indicate layout of proposed server location in Shop Drawings.
- C. Install software indicated on server(s) and verify that software functions properly.

- D. Develop Project-specific graphics, trends, reports, logs, and historical database.
- E. Power servers through dedicated UPS unit. Locate UPS adjacent to server. Install rack-mounted UPS units for powering rack-mounted servers and tower UPS units for tower servers.

3.8 INSTALLATION OF GATEWAYS

- A. Install gateways if required for DDC system communication interface requirements indicated.
 - 1. Install gateway(s) required to suit indicated requirements.
- B. Test gateways to verify that communication interface functions properly.

3.9 INSTALLATION OF ROUTERS

- A. Install routers if required for DDC system communication interface requirements indicated.
 - 1. Install router(s) required to suit indicated requirements.
- B. Test routers to verify that communication interface functions properly.

3.10 INSTALLATION OF CONTROLLERS

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply and to UPS units where indicated.
- C. Install controllers 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. DDC system provider and DDC system manufacturer to determine quantity and location of network controllers to satisfy requirements indicated.
 - 2. Install controllers in a protected location that is easily accessible by operators.
 - 3. Locate top of controller within 72 inches of finished floor.
- F. Installation of Programmable Application Controllers:
 - 1. DDC system provider and DDC system manufacturer to determine quantity and location of programmable application controllers to satisfy requirements indicated.
 - 2. Install controllers in a protected location that is easily accessible by operators.
 - 3. Locate top of controller within 72 inches of finished floor, except where dedicated controllers are installed at terminal units.
- G. Application-Specific Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of application-specific controllers 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.

3.11 INSTALLATION OF ENCLOSURES

- 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 Enclosures: Type 1; use painted steel strut and hardware.
 2. For NEMA 250 Enclosures and Enclosures Located Outdoors: Type 4 or Type 4X; 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 stainless steel anchors.
- E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireways used for application are to have protection equal to NEMA 250 rating of connected enclosures.

3.12 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections.
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade to provide a fully functioning DDC system. Work is to comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.
- E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power raceways and boxes.

3.13 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner's Representative and provide unique naming and addressing for networks and devices.
- B. ASHRAE 135 Networks:
 - 1. MAC Address:
 - a. Assign and document a MAC address unique to its network for every network device.
 - b. Ethernet Networks: Document MAC address assigned at its creation.
 - c. 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 is to support up to 4,194,302 unique devices.
 - 4. Device Object Name Property Text:
 - a. Device object name property field to 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 heating water boiler plant at Building 1000 would be "Heating Water System Bldg. 1000."
 - 2) Example 2: Device object name for VAV terminal unit controller could be "VAV Unit 102."
 - 5. Object Name Property Text for Other Than Device Objects:
 - a. Object name property field is to 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. Assign object identifier property numbers according to Drawings or tables indicated.

- b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner's Representative in advance, be documented, and be unique for like object types within device.

3.14 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

- A. Comply with NECA 1.
- B. Wire and Cable Installation:
 - 1. Comply with installation requirements in Division 26.
 - 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 a junction box.
 - b. Individual conductors in the stripped section of cable is to 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 in accordance with 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 Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems".

3.15 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. Verify that control dampers are installed correctly for flow direction.

2. Verify that proper blade alignment, either parallel or opposed, has been provided.
3. Verify that damper frame attachment is properly secured and sealed.
4. Verify that damper actuator and linkage attachment are secure.
5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
6. Verify that damper blade travel is unobstructed.

F. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments, verify the following:
 - a. Sensing element type and proper material.
 - b. Length and insertion.

3.16 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 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 three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
 1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.
- F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.
- G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.
- H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

I. 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.

J. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Meters: Check meters at zero, 50, and 100 percent of Project design values.

M. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

N. Switches: Calibrate switches to make or break contact at set points indicated.

O. 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.

3.17 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 backup power source.
6. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.18 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 are as indicated and as required 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 that 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's 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 must match.
10. Prepare and submit 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.

3.19 FINAL REVIEW

- A. Submit written request to Architect Commissioning Agent when DDC system is ready for final review. 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. Upon receipt of written request for final review, Commissioning Agent to start review within reasonable period and upon completion issue field report(s) documenting observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Compensation for Subsequent Reviews: Should more than two reviews be required, DDC system manufacturer and Installer to compensate entity/entities performing reviews for total costs (labor and expenses) associated with subsequent reviews. Estimated cost of each subsequent review to be submitted and approved by DDC system manufacturer and Installer before review.

- E. Prepare and submit closeout submittals and begin procedures indicated in "Extended Operation Test" Article when no deficiencies are reported.
- F. Part of DDC system final review to include 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 to include, but not be limited to, the following:
 - a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. 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 hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points to 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's ability to communicate with controllers, operator workstations, and uploading and downloading of control programs.
 - i. Software's ability to edit control programs offline.
 - 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 Controller: Applies to network and programmable application controllers.
 - 1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation are not to be lost during power failure.
 - 2) Operator Interface: Ability to connect directly to each type of digital controller with portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's 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 controller's 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. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's 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 operator using workstation graphics, or by completing a field in 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's Representative. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient 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 sufficient privilege.
 - 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
 - 9) Modification of Trend Log Object Parameters: Operator with sufficient 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.

3.20 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, verify that maintenance service includes three months' full maintenance by DDC system manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration, and adjusting as required for proper operation. Use only manufacturer's authorized replacement parts and supplies.

3.21 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, verify that service agreement includes software support for one year(s).
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year(s) from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: No fewer than 30 days to allow Owner's Representative to schedule and access system and to upgrade computer equipment if necessary.

3.22 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:
 - 1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 - 2. Inform Owner's Representative of anticipated training requirements if more than minimum training requirements are indicated.
 - 3. Minimum Training Requirements:
 - a. Provide not less than five days of training total.
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training to occur before end of warranty period.
 - c. Break down total days of training into not more than two separate training classes.
 - d. Schedule training so each training class is not less than one consecutive day(s).
- C. Training Schedule:
 - 1. Schedule training with Owner's Representative 20 business days before expected Substantial Completion.

2. Schedule training to provide Owner's Representative with at least 10 business days of notice in advance of training.
 3. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session to be split in half with 15-minute break between sessions. Morning and afternoon sessions to be separated by 30-minute lunch period. Training, including breaks and excluding lunch period, are not to exceed eight hours per day.
 4. Provide staggered training schedule as requested by Owner's Representative.
- D. Training Attendee List and Sign-in Sheet:
1. Request from Owner's Representative in advance of training a proposed attendee list with name, phone number, and email address.
 2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
 3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
 4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
 5. At end of each training day, send Owner's Representative an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session. Indicate which attendees, if any, joined for only part of training sessions.
- E. Training Attendee Headcount:
1. Plan in advance of training for two attendees.
 2. Make allowance for Owner's Representative to add up to one attendee(s) at time of training.
 3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.
- F. Attendee Training Manuals:
1. Provide each attendee with color hard copy of all training materials and visual presentations.
 2. Organize hard-copy materials in three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
 3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a flash drive with PDF copy of all hard-copy materials.
- G. Instructor Requirements:
1. One or multiple qualified instructors, as required, to provide training.
 2. Use instructors who have provided not less than five years of instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.
- H. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
 - a. Daily operators.
 - b. Advanced operators.
 - c. System managers and administrators.
 2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions to ensure DDC system security.
- I. Training Outline:
1. Submit training outline for Owner's Representative review at least 10 business day before scheduling training.
 2. Include in outline a detailed agenda for each training day that is broken down into training sessions that day, training objectives for each training session, and synopses for each lesson planned.
- J. On-Site Training:
1. Owner's Representative will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
 2. Provide training materials, projector, and other audiovisual equipment used in training.
 3. Provide as much of training located on-site as deemed feasible and practical by Owner's Representative.
 4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
 5. Use operator workstation that is to be used with DDC system in the training. If operator workstations are unavailable, provide temporary workstation to convey training content.
- K. Off-Site Training:
1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power, and data connectivity for each attendee.
 2. Provide capability to remotely access to Project DDC system for use in training.
 3. Provide operator workstation for use by each attendee.
- L. Training Content for Daily Operators:
1. Basic operation of system.
 2. Understanding DDC system architecture and configuration.
 3. Understanding each unique product type installed including performance and service requirements for each.
 4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm, and each unique optimization routine.
 5. Operating operator workstations, printers, and other peripherals.
 6. Logging on and off system.
 7. Accessing graphics, reports, and alarms.
 8. Adjusting and changing set points and time schedules.
 9. Recognizing DDC system malfunctions.

10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
 - a. Operation of HVAC equipment in normal-off, normal-on, and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
 - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
 - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles, and other modes of operation indicated.
 - d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
 - e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
 - f. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
 - g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

M. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading, and offline archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

N. Video of Training Sessions:

1. Provide digital video and audio recording of each training session. Create separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Owner's Representative with copies of digital files on cloud and flash drives for later reference and for use in future training.
4. Owner's Representative retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 230923

SECTION 230923.12 - CONTROL DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular control dampers with flat blades.
2. Electric and electronic control-damper actuators.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 DEFINITIONS

A. DDC: Direct digital control.

B. 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.

C. Thermal Efficiency Ratio (E): Comparison of a tested damper's thermal performance against a v-groove blade reference damper. A damper with the same thermal efficiency as the reference damper would have an E value of 0 percent, while a damper that is 4 times as efficient would have an E value of 200 percent.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Rectangular control dampers with flat blades.
2. Electric and electronic control-damper actuators.

B. Product Data Submittals: For each damper and actuator.

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 instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product 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 Submittals:

1. Schedule and design calculations for control dampers and actuators, including the following:
 - a. Unique designation for each damper/actuator assembly.
 - b. Service/application.
 - c. Damper assembly size.
 - d. Damper assembly weight, including actuator(s).
 - e. Damper and actuator action (two position).
 - f. Flow at project design and minimum flow conditions.
 - g. Face velocity at project design and minimum airflow conditions.
 - h. Pressure drop across damper at project design and minimum airflow conditions.
 - i. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
 - j. Maximum close-off pressure.
 - k. Leakage airflow at maximum system pressure differential (fan close-off pressure).
 - l. Damper torque required at worst-case condition for sizing actuator.
 - m. Actuator selection indicating torque provided.
 - n. Actuator fail-safe position on loss of power and loss of signal.
 - o. Remarks listing special requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For control dampers.

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. ASHRAE 62.1 Compliance: Applicable outdoor ventilation requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. Code Compliance: Comply with governing energy code.
- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

- F. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.
- G. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.
- H. Selection Criteria:
 - 1. Multi-Blade Damper Configuration: As follows unless otherwise indicated on Drawings:
 - a. Two-Position Control: Opposed or parallel.
 - 2. Pressure and Temperature: Control dampers suitable for operating conditions encountered by the application and following conditions unless otherwise indicated on Drawings:
 - a. Outdoor Air: 0 to 120 degrees F and exhaust fan total static pressure as a negative value as scheduled on the drawings.
 - b. Exhaust Air: Scheduled system exhaust air temperature and either the exhaust fan total static pressure as a negative or positive value, depending on upstream or downstream of fan, as scheduled on the drawings.
 - 3. Fail-Safe Positions: As follows unless otherwise indicated on Drawings:
 - a. Outdoor Air: Close.
 - b. Exhaust Air: Close.
 - 4. Select dampers with smooth and stable operation throughout full range of operation over varying pressures and temperatures encountered.
 - 5. Sizing: As follows unless otherwise indicated on Drawings
 - a. Two-Position Dampers: Full size of duct or equipment connection unless otherwise indicated.

2.2 RECTANGULAR CONTROL DAMPERS WITH FLAT BLADES

- A. General Requirements:
 - 1. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
 - a. Include multisection damper assemblies with intermediate reinforcing where required between individual sections being joined together. Construct reinforcing of same material as damper frame.
 - 2. Factory install actuator(s) as integral part of damper assembly. Coordinate, with damper manufacturer, field requirements for actuators, such as type, fail-safe position, power supply, location, and mounting requirements.
- B. Rectangular Control Dampers with Galvanized-Steel Flat Blades and Frames:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. American Warming and Ventilating (AWV); Mestek, Inc.
 - b. Arrow United Industries; Mestek, Inc.
 - c. Greenheck Fan Corporation.
 - d. Johnson Controls, Inc.
 - e. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
2. Source Limitations: Obtain rectangular control dampers, with galvanized-steel flat blades and frames, from single manufacturer.
3. AMCA Certification: Test, rate, and seal, in accordance with AMCA 511 for air performance and air leakage.
4. Performance:
 - a. Leakage:
 - 1) AMCA 511, Class II, at 1 in. wg Differential Static Pressure: Leakage not to exceed 5.4 cfm/sq. ft. against 1 in. wg differential static pressure when tested in accordance with AMCA 500D.
 - b. Pressure Drop: 0.1 in. wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500D, figure 5.3.
 - c. Pressure Rating: 4.0 in. wg.
 - d. Temperature: Minus 20 to plus 185 deg F.
 - e. Velocity: Up to 2000 fpm.
5. Construction:
 - a. Frame:
 - 1) Material: ASTM A653/A653M galvanized steel, minimum 0.06 inch thick.
 - 2) Arrangement: Hat-shaped channel with integral extended face flange(s) having mating face of minimum 2 inches for attachment to duct flanges, plenum walls, and equipment.
 - 3) Width: Not less than 5 inches.
 - b. Blades:
 - 1) Configuration: Parallel or opposed blade configuration as required by application.
 - 2) Material: ASTM A653/A653M galvanized steel, 0.06 inch thick.
 - 3) Shape: Single thickness with bends for reinforcing.
 - 4) Length: As required by pressure rating, not to exceed 48 inches.
 - 5) Width: Not to exceed 8 inches.
 - c. Seals:
 - 1) Blades: Replaceable; extruded silicone, vinyl, or damper manufacturer-offered equivalent, as required by performance requirements. Seals are to be mechanically attached in extruded blade slots.
 - 2) Jambs: Stainless steel, compression type.
 - d. Axles:
 - 1) Diameter: Minimum 0.375 inch.
 - 2) Material: Plated steel or stainless steel, specific to application indicated.

- 3) Mechanically attached to blades.
- e. Bearings:
 - 1) Material: Molded nylon or synthetic, or stainless-steel sleeve, as required by operating conditions, mounted in frame.
 - 2) Where blade axles are installed in vertical position, provide thrust bearings.
- f. Linkage:
 - 1) Hardware: Plated or stainless steel.
 - 2) Material: Plated steel or stainless steel, specific to application indicated.
 - 3) Mounting: Concealed in frame.
- g. /Transitions with Sleeve:
 - 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connections.
 - 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
 - a) Sleeve length not less than 12 inches for dampers without jackshafts and not less than 16 inches for dampers with jackshafts.
 - b) Oversize damper and sleeve for duct connection size plus minimum 4 inches.
 - 3) Fabricate sleeve and transitions of galvanized steel.
 - 4) Match end connections (flange or sleeve) to field connections./

2.3 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

- A. Select actuators to 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.
- B. Select actuators with sufficient power and torque to close off against the maximum system pressures encountered. Actuators are to be sized to close off against the fan shutoff pressure as a minimum requirement.
- C. The total damper area operated by an actuator is not to exceed 80 percent of manufacturer's maximum area rating.
- D. Provide one actuator for each damper assembly where possible. Operate multiple actuators required to drive a single damper assembly in unison.
- E. Avoid the use of excessively oversized actuators, which could overdrive and cause linkage failure when the damper blade has reached either its fully open or closed position.
- F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
- G. Provide mounting hardware and linkages for connecting actuator to damper.

- H. Select actuators to fail-safe in desired position in the event of a power and signal failure.
- I. Actuator Fail-Safe Positions: As indicated below or as indicated on the drawings:
 - 1. Outdoor Air: Close.
 - 2. Exhaust Air: Close.

2.4 ELECTRIC AND ELECTRONIC CONTROL-DAMPER ACTUATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belimo Aircontrols (USA), Inc.
 - 2. Honeywell Building Solutions; Honeywell International, Inc.
 - 3. Johnson Controls, Inc.
 - 4. Schneider Electric USA, Inc.
 - 5. Siemens Industry, Inc., Building Technologies Division.
- B. Source Limitations: Obtain electric and electronic control-damper actuators from single manufacturer.
- C. Type: Motor operated, with or without gears, electric and electronic.
- D. Voltage:
 - 1. Voltage selection is delegated to professional designing control system.
 - 2. Actuator to deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
 - 3. Actuator to function properly within a range of 85 to 120 percent of nameplate voltage.
- E. Construction:
 - 1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed-steel enclosures.
 - 2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains are to be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
 - 3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
- F. Local Field Adjustment: Make spring-return actuators easily switchable from fail-safe open to fail-safe closed in the field without replacement.
- G. Local Manual Override: Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.
- H. Two-Position Actuators: Single direction, spring return or reversing type.
- I. Position Feedback:
 - 1. Where indicated, equip two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of open and closed position.

2. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

J. Fail-Safe:

1. Where indicated, provide actuator to fail-safe to an end position.
2. Internal spring-return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other nonmechanical forms of fail-safe operation are acceptable only where uniquely indicated.

K. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

L. 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 setscrew method of attachment is acceptable only if provided with at least two points of attachment.

M. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range is to be from 5 to 95 percent relative humidity, noncondensing.

N. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 or Type 4 for indoor and protected applications.
3. Provide actuator enclosure with a heater and controller where required by application.

O. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation, and as follows.
 - a. Operate damper from fully closed to fully open position within 15 seconds.
 - b. Operate damper from fully open to fully closed position within 15 seconds.
 - c. Move damper to fail-safe position within 15 seconds.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL-DAMPER APPLICATIONS

- A. Select from damper types indicated to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
- B. Rectangular Control-Damper Applications:
 - 1. Exhaust Air: Rectangular dampers with galvanized steel flat blades; 0.15-inch w.g. maximum air pressure and 2,000 feet per minute maximum air velocity.
 - 2. Outdoor Air: Rectangular dampers with galvanized steel flat blades 0.15-inch w.g. maximum air pressure and 2,000 feet per minute maximum air velocity.

3.3 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic, wind, or others forces common to the application.
- C. Provide wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Seal penetrations made in fire-rated and acoustically rated assemblies.
- E. Fastening Hardware:
 - 1. Wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
 - 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.
- F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 CONTROL DAMPERS

- A. Install smooth transitions, not exceeding 15 degrees, to dampers larger or 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.
- B. 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 of clear space on sides of dampers requiring service access unless more space is recommended by manufacturer. Provide code required clearances as applicable.
- C. Service Access:
 - 1. Install dampers and actuators to 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 Section 233300 "Air Duct Accessories."
- D. Install dampers straight and true, level in all planes, and square in all dimensions.
- E. Install supplementary structural reinforcement for large multiple-section dampers if factory-furnished support alone cannot handle loading.
- F. Attach field-installed actuator(s) to damper drive shaft.
- G. For duct-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with damper identification on damper and on face of ceiling where damper is concealed above ceiling.

3.6 ELECTRICAL CONNECTIONS

- A. Install electrical power to field-mounted control devices requiring electrical power.
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors .
- C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

- E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.7 CONTROL CONNECTIONS

- A. Install control signal wiring to field-mounted control devices.
- B. Connect control signal wiring in accordance with Division 26.
- C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.8 STARTUP

- A. Control-Damper Checkout:
 - 1. Check installed products before continuity tests, leak tests, and calibration.
 - 2. Check dampers for proper location and accessibility.
 - 3. Verify that control dampers are installed correctly for flow direction.
 - 4. Verify that proper blade alignment, either parallel or opposed, has been provided.
 - 5. Verify that damper frame attachment is properly secured and sealed.
 - 6. Verify that damper actuator and damper linkage attachment are secure.
 - 7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 - 8. Verify that damper blade travel is smooth and unobstructed throughout operating range.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
- B. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- C. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.12

SECTION 230923.16 - GAS INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Carbon dioxide sensors and transmitters.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, cable, and other requirements that relate to this Section.

1.2 DEFINITIONS

- A. NDIR: Nondispersive infrared.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Carbon dioxide sensors and transmitters,

B. Product Data Submittals: For each product.

1. 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.
2. Installation instructions, including factor affecting performance.
3. Product description with complete technical data, performance curves, product specification sheets.
4. Product data indicating ASHRAE 62.1 compliance.

C. Shop Drawings:

1. Plans, elevations, sections, and **mounting** details.
2. Diagrams for power, signal, and control wiring.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For carbon dioxide sensors and transmitters, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For gas instruments.

PART 2 - PRODUCTS

2.1 CARBON DIOXIDE SENSORS AND TRANSMITTERS

- A. Carbon Dioxide Sensors and Transmitters, Duct Mounted:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Building Automation Products Inc.; BAPI.
 - b. Dwyer Instruments, Inc.
 - c. Greystone Energy Systems, Inc.
 - d. Honeywell Building Solutions; Honeywell International, Inc.
 - e. Johnson Controls, Inc.
 - f. Telaire; a brand of Amphenol Thermometrics Inc.
 - g. Vaisala.
 - h. Veris Industries.
2. Source Limitations: Provide carbon dioxide sensors and transmitters, duct mounted, from single manufacturer.
3. Description:
 - a. NDIR or equivalent technology that provides performance indicated, long-term stability, and reliability.
4. Performance:
 - a. Air Velocity Range: 0 to 2000 fpm.
 - b. Carbon Dioxide Concentration Range: Zero to 2000 ppm.
 - c. Accuracy: Within 2 percent of reading, plus or minus 30 ppm.
 - d. Repeatability: Within 1 percent of full scale.
 - e. Long-Term Stability: Within 5 percent of full scale after more than 5 years.
 - f. Response Time: Within 60 seconds.
 - g. Warm-up Time: Within 1 minute(s).
 - h. Ambient Relative Humidity: Zero to 85 percent noncondensing.
 - i. Ambient Temperature: 23 to 113 deg F or 32 to 122 deg F.
5. Output Signals:
 - a. Analog Output Signal: 4 to 20 mA or zero to 10 V dc output signal, linearized to carbon dioxide concentration in parts per million (ppm).
 - b. Digital Output Signal: SPST or SPDT.

6. Serial Communication: BACnet MS/TP or Modbus RTU.
 7. Construction:
 - a. Enclosure: Painted metal or plastic; equivalent to NEMA 250, Type 1 or Type 4.
 - b. Electrical Connections: Screw terminals.
 - c. Visual Display: Equip with digital display for continuous indication of carbon dioxide concentration only where indicated on Drawings.
 8. Calibration Kit: Provide kit and turnover to Owner at start of warranty period.
- B. Carbon Dioxide Sensors and Transmitters, Wall Mounted:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ACI Automation; Automation Components Inc.
 - b. Building Automation Products Inc.; BAPI.
 - c. Dwyer Instruments, Inc.
 - d. Greystone Energy Systems, Inc.
 - e. Honeywell Building Solutions; Honeywell International, Inc.
 - f. Johnson Controls, Inc.
 - g. Telaire; a brand of Amphenol Thermometrics Inc.
 - h. Vaisala.
 - i. Veris Industries.
 2. Source Limitations: Provide carbon dioxide sensors and transmitters, wall mounted, from single manufacturer.
 3. Description:
 - a. NDIR or equivalent technology that provides performance indicated, long-term stability, and reliability.
 4. Performance:
 - a. Carbon Dioxide Concentration Range: Zero to 2000 ppm.
 - b. Accuracy: Within 2 percent of reading, plus or minus 30 ppm.
 - c. Repeatability: Within 1 percent of full scale.
 - d. Long-Term Stability: Within 5 percent of full scale after more than 5 years.
 - e. Response Time: Within 60 seconds.
 - f. Warm-up Time: Within 5 minutes.
 - g. Ambient Relative Humidity: Zero to 95 percent noncondensing.
 - h. Ambient Temperature: 32 to 122 deg F.
 5. Output Signals:
 - a. Analog Output Signal: 4 to 20 mA or zero to 10 V dc output signal, linearized to carbon dioxide concentration in parts per million (ppm).
 - b. Digital Output Signal: SPST or SPDT.
 6. Serial Communication: BACnet MS/TP or Modbus RTU.
 7. Construction:
 - a. Enclosure: White plastic; equivalent to NEMA 250, Type 1.
 - b. Electrical Connections: Screw terminals.

- c. Visual Display: Equip with digital display for continuous indication of carbon dioxide concentration only where indicated on Drawings.
- 8. Calibration Kit: Provide to Owner at start of warranty period.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates 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 instruments to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to external loads.
- D. Fastening Hardware:
 - 1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

- A. Mounting Location:
 - 1. Mount duct-mounted instruments at locations indicated on Drawings.
 - 2. Mount wall-mounted instruments in user-occupied space at locations indicated on Drawings.
 - 3. Mount instruments intended for wall-mounting using floor-supported freestanding pipe stands, or floor-supported structural support frames where direct-to-wall mounting is not

possible. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height is to comply with codes and accessibility requirements.
2. Mount instruments 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. 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.

3.4 ELECTRICAL CONNECTIONS

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."
- E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.5 CONTROL CONNECTIONS

- A. Install control signal wiring to field-mounted control devices.
- B. Connect control signal wiring in accordance with Division 26.
- C. Furnish and install raceways. Comply with requirements of Division 26.

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have same designation at each end for operators to determine continuity at points of

connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- B. Install engraved phenolic nameplate with instrument identification on face and on face of ceiling directly below instruments concealed above ceilings.

3.7 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.8 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation that impacts performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration are to comply with instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments are to have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent is to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument in accordance with instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures in ASHRAE's Guideline 11, in the absence of specific requirements, and to supplement requirements indicated.

B. 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.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Transmitters: Check and calibrate transmitters at zero, 50, and 100 percent of Project design values. Field calibration is not required for instruments that have been factory calibrated and provided with certificates.

3.10 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, verify that maintenance service includes 12 months' full maintenance by skilled employees of gas system and equipment Installer. Include semiannual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 230923.16

SECTION 230923.23 - PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.
4. Air-pressure three-in-one combination controller/switch/transmitter.

B. Related Requirements:

1. Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 DEFINITIONS

A. HART: Highway addressable remote transducer protocol.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.

B. Product Data Submittals: For each product.

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 instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.

2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each product requiring a certificate.
- B. Product Test Reports: For each product requiring test performed by manufacturer and witnessed by a qualified testing agency.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Environmental Conditions:
 1. Instruments must operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated and cooled, filtered, and ventilated as required by instrument and application.
 2. Protect instruments and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated are to be housed in protective secondary enclosures. Base NEMA 250 enclosure requirements on instrument-installed locations as follows:
 - a. Outdoors, Protected: Type 3 or Type 12.
 - b. Outdoors, Unprotected: Type 4 or Type 4X.
 - c. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2, Type 3 or Type 12.
 - d. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4 or Type 4X.

2.2 AIR-PRESSURE SENSORS

A. Air-Pressure Sensor, Static Pressure Duct Traverse Type:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Monitor; an ONICON Brand.
 - b. Paragon Controls Incorporated.
2. Description: Sensor to traverse the duct cross section and have at least one pickup point every 6 inches along length of sensor.
3. Design: Dual offset static sensor designed to provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30-degree yaw and pitch.
4. Performance:
 - a. Accuracy: Within 1 percent of actual operating static pressure.
 - b. Air Resistance (Pressure Drop): Less than 0.1 times the velocity pressure at probe-operating velocity.
 - c. Temperature: Up to 200 deg F.
 - d. Velocity: 0 to 10000 fpm.
5. Process Connection: Mounting plate with threaded compression fitting for connection to tubing or threaded NPT connection.
6. Construction Material: Type T6063-T5 extruded and anodized aluminum or Type 316 stainless steel.
7. Mounting: Sensor supported with noncorrosive threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at opposite end.
8. Pressure Signal Dampener: Provide sensor assembly with dampener to minimize erratic and rapid fluctuations in pressure signal.
9. Duct Type: Suitable for flat oval, rectangular, and round duct configurations.

2.3 AIR-PRESSURE SWITCHES

A. Air-Pressure Switch, Differential Type:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cleveland Controls Inc.
 - b. Dwyer Instruments, Inc.
 - c. Johnson Controls, Inc.
 - d. Penn Controls.
2. Description: Diaphragm operated to actuate an SPDT snap switch.
 - a. Fan Safety Shutdown Applications: Switch with manual reset and SPST snap switch.
3. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Performance:

- a. Accuracy/Repeatability: Within **3** percent of set point.
 - b. Electrical Rating: 15 A at 120 to 480 V ac.
 - c. Pressure Limits:
 - 1) Continuous: 45 inches wg.
 - 2) Surge: 10 psig.
 - d. Pressure Range: Approximately 2 times set point.
 - e. Temperature Limits: Minus 30 to plus 180 deg F.
- 5. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
 - 6. Process Connections: Threaded NPT or compression fittings.
 - 7. Conduit Connections: Knock out or threaded connection(s) for trade-size conduit.
 - 8. Wiring Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
 - 9. Enclosure Material: Corrosion-resistant metal.
 - 10. Enclosure Rating:
 - a. Dry Indoor Installations: NEMA 250, Type 1.
 - b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
 - c. Hazardous Environments: Explosion proof.

B. Air-Pressure Switch, Differential Type - with Set-Point Indicator:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Dwyer Instruments, Inc., Series 1630
- 2. Description: Diaphragm operated to actuate an SPDT snap switch.
- 3. Certification: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 4. Performance:
 - a. Accuracy/Repeatability: Within 1 percent.
 - b. Electrical Rating: 15 A at 120 to 480 V ac.
 - c. Pressure Limits:
 - 1) Continuous: 10 psig.
 - 2) Surge: 25 psig.
 - d. Pressure Range: Approximately 2 times set point.
 - e. Temperature Limits: Minus 30 to plus 110 deg F.
- 5. User Interface: Screw-type set-point adjustment with visible enclosed set-point indicator and scale.
- 6. Process Connections: Threaded NPT, 1/8 inch.
- 7. Conduit Connection: Knock out or threaded connection.
- 8. Wiring Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
- 9. Enclosure Material: Corrosion-resistant metal.
- 10. Enclosure Rating:

- a. Dry Indoor Installations: NEMA 250, Type 1.
- b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.

2.4 AIR-PRESSURE TRANSMITTERS

A. Air-Pressure Transmitter, Differential Type - with Display:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Dwyer Instruments, Inc.
 - c. Paragon Controls Incorporated.
 - d. Setra Systems Inc.
2. Performance:
 - a. Range: Approximately 2 times set point.
 - b. Accuracy: Within 0.25 percent of the full-scale range.
 - c. Hysteresis: Within 0.10 percent of full scale.
 - d. Repeatability: Within 0.05 percent of full scale.
 - e. Stability: Within 0.1 percent of full scale range.
 - f. Overpressure: 10 psig.
 - g. Temperature Limits: Zero to 150 deg F.
 - h. Compensated Temperature Limits: 40 to 150 deg F.
 - i. Thermal Effects: 0.033 percent of full scale per degree F.
 - j. Transmitter is to be shock and vibration tolerant without impacting performance.
3. Output Signals Contractors Option:
 - a. Analog Current Signal:
 - 1) Two-wire, 4 to 20 mA dc current source.
 - 2) Signal capable of operating into 800-ohm load.
 - b. Analog Voltage Signal:
 - 1) Three wire, zero to 5 or 10 V.
 - 2) Minimum Load Resistance: 1000 ohms.
4. Display: Four-digit digital display with minimum 0.4-inch- high numeric characters.
5. Operator Interface: Zero and span adjustments located on face or behind cover.
6. Construction:
 - a. Enclosure Material: Plastic enclosure with removable plastic cover.
 - b. Enclosure Rating: NEMA 250, Type 2, Type 4 or Type 4X as appropriate.
 - c. Process Connections: Threaded, NPT swivel fittings for connection to copper tubing or barb fittings for connection to polyethylene tubing.
 - d. Wiring Connections: Screw terminal block; reverse wiring protected.
 - e. Mounting: Vertical plane mounting.
 - f. Provide mounting bracket suitable for installation.

7. Factory Calibration: Calibrate to NIST-traceable standards and provide a certificate of calibration for each transmitter.

2.5 AIR-PRESSURE THREE-IN-ONE COMBINATION CONTROLLER / SWITCH / TRANSMITTER

A. Air-Pressure Three-in-One Combination Controller/Switch/Transmitter, Differential Type - with Indicator:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Dwyer Instruments, Inc., Series DH3 Digihelic
2. Description:
 - a. Three-in-one instrument, including digital display, controller, control relay switches, and a transmitter with a current output.
 - b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
 - c. Select instrument range based on application. Range to be approximately 2 times set point.
3. Performance:
 - a. Accuracy Including Hysteresis and Repeatability:
 - 1) Within 1.5 percent for ranges 0.25 in. wg and less.
 - 2) Within 1 percent for ranges 0.5 in. wg to 5 in. wg.
 - 3) Within 0.5 percent at 77 deg F for other ranges.
 - b. Stability: Within 1 percent per year.
 - c. Response Time: 250 ms.
 - d. Overpressure: Varies with range; at least 5 times pressure range and not less than 1.5 psig.
 - e. Temperature Limits: 32 to 140 deg F.
 - f. Compensated Temperature Limits: 32 to 140 deg F.
 - g. Thermal Effects: 0.020 percent per degree F.
 - h. Warm-up Period: One hour.
4. Controller Programming through Menu Keys to Access Five Menus:
 - a. Security level.
 - b. Pressure, velocity, or flow application.
 - c. Engineering units.
 - d. K-factor for use with flow application.
 - e. Set-point control only; set-point and alarm operation; and alarm operation as high, low, or high/low with manual or automatic reset and delay.
 - f. View high and low readings.
 - g. Digital dampening for smoothing erratic applications.
 - h. Scaling of analog output to fit range and field calibration.
5. Display:

- a. Digital, four-digit display with backlight, with 0.4-inch- high alphanumeric characters.
 - b. Four indicators; two for set point and two for alarm status.
- 6. Operator Interface:
 - a. Set-point adjustment through keypad on face of instrument.
 - b. Zero and span adjustments accessible through menu.
 - c. Programming through keypad.
- 7. Analog Output Signal:
 - a. Two-wire, 4 to 20 mA dc current source.
 - b. Signal capable of operating into a 900-ohm load.
- 8. Digital Output Signal: Two SPDT relays, each rated for one amp at 30 V ac or dc.
- 9. Construction:
 - a. Enclosure Face: Nominal 5-inch- diameter face.
 - b. Enclosure Material: Die-cast-aluminum casing and brushed Type 304 stainless steel bezel.
 - c. Enclosure Rating: NEMA 250, Type 1.
 - d. Process Connections: Threaded, 1/8-inch NPT connections on side or back as required by application.
 - e. Mounting: Vertical plane mounting.
 - f. Mounting Bracket: Appropriate for installation.
- 10. Factory Calibration: Calibrate to NIST-traceable standards and provide each transmitter with a certificate of calibration.

2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.
- B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates 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 instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PRESSURE INSTRUMENT APPLICATIONS

- A. Install instruments of type as necessary to perform the sequence of operations as indicated on the Drawings.

3.3 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment.
- C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRICAL CONNECTIONS

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.5 INSTALLATION OF PRESSURE INSTRUMENTS

- 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 pressure associated with individual air-handling units and associated connected ductwork 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 air-pressure switches and transmitters where required to comply with intended sequences of operation unless indicated specifically on Drawings.
 4. 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.
 5. Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 3 percent.
- B. Mounting Height:
1. Mount remote displays, 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. Mount at 60 inches.
- C. 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.
- D. Duct Pressure Sensors:
1. Install sensors using manufacturer's recommended upstream and downstream distances.
 2. Unless indicated on Drawings, locate sensors approximately 67 percent of distance of longest hydraulic run. Location of sensors to be submitted and approved before installation.
 3. Install mounting hardware and gaskets to make sensor installation airtight.
 4. Route tubing from the sensor to transmitter.
 5. Use compression fittings at terminations.
 6. Install sensor in accordance with manufacturer's instructions.
 7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.
- E. 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 3/8-inch 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.

3.6 ELECTRIC POWER

- A. Provide electrical power to products requiring electrical connections.
- B. Provide power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Provide raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."
- E. Provide circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- F. Install electrical devices furnished by instrument manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- G. Install nameplate at each instrument electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.7 CONTROL CONNECTIONS

- A. Install control signal wiring to field-mounted control devices.
- B. Connect control signal wiring in accordance with Division 26.
- C. Provide raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.8 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.9 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.10 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.

- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

3.11 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Description:
 - 1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
 - 2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
 - 3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
 - 4. Equipment and procedures used for calibration to comply with instrument manufacturer's recommendations.
 - 5. Provide diagnostic and test equipment for calibration and adjustment.
 - 6. Field instruments and equipment used to test and calibrate installed instruments to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent to be checked by an instrument with an accuracy of 0.5 percent.
 - 7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
 - 8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
 - 9. 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.
- B. 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.
- C. Digital Signals:
 - 1. Check digital signals using a jumper wire.
 - 2. Check digital signals using an ohmmeter to test for contact.
- D. Sensors: Check sensors at zero, 50, and 100 percent of project design values.
- E. Switches: Calibrate switches to make or break contact at set points indicated.
- F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of project design values. Field calibration is not required for instruments that have been factory calibrated and provided with certificates.

3.12 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.

3.13 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies to be manufacturer's authorized replacement parts and supplies.

3.14 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate pressure instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner has right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.23

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Automatic condensate pump units.

1.2 ACTION SUBMITTALS

- A. Product Data: For each pump.
 - 1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
 - 2. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps operation, and maintenance manuals.

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.

2.2 AUTOMATIC CONDENSATE PUMP UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Beckett Corporation.
 - 2. Crane Pumps & Systems.

3. Grundfos Pumps Corporation.
 4. Hartell Pumps; Milton Roy.
 5. Little Giant; a brand of Franklin Electric Co., Inc.
- B. Source Limitations: Obtain pump units from single source from single manufacturer.
- C. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Collects and removes condensate from fan coil units, air handling units, condensing boilers, and similar components. Include factory- or field-installed check valve and 72-inch-minimum, electrical power cord with plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.3 PIPING CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "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.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Valves and specialties.
3. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For the following with each non packaged DX equipment:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Strainers.
5. Filter dryers.
6. Pressure-regulating valves.
7. Mufflers.

B. Product Data Submittals: For each non packaged DX system.

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

C. Delegated Design Submittals: For refrigerant piping size, expansion and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Shop Drawings:

1. Show piping size, expansion and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports: For each field quality control test and inspection.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.
- B. Prepare valves and specialties for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads and other end connections.
- C. Use the following precautions during storage:
 - 1. Maintain valve and specialty end protection.
 - 2. Store valves and specialties indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- B. For A2L refrigerants, comply with UL 484, UL/CSA 60335-2-40 or UL/CSA 60335-2-89.
- C. Comply with ASHRAE 15.
- D. Comply with ASME B31.5.
- E. Test Pressure for Refrigerant R-454B:
 - 1. Suction Tubing Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 300 psig.
 - 2. Suction Tubing for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Tubing: 535 psig.
- F. Test Pressure for Refrigerant R-410A:
 - 1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 300 psig.
 - 2. Suction Tubing for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Tubing Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B280, Type ACR.
- B. Wrought-Copper Fittings, Solder Joint: ASME B16.22.
- C. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- F. Brazing Filler Metals: AWS A5.8M/A5.8.
- G. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 535 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker (Parker Hannifin).
 - 2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 3. Diaphragm: Phosphor bronze and stainless steel with stainless steel spring.
 - 4. Operator: Rising stem and hand wheel.
 - 5. Seat: Nylon.
 - 6. End Connections: Socket, union, or flanged.
 - 7. Working Pressure Rating: 500 psig.
 - 8. Maximum Operating Temperature: 240 deg F.
- B. Packed-Angle Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker (Parker Hannifin).

2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Danfoss, Inc.
 - c. Emerson Climate Technologies; Emerson Electric Co.
 - d. Henry Technologies Inc.; The Henry Group.
 - e. Parker (Parker Hannifin).
2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal as required by the equipment manufacturer.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
 - d. JB Industries.
 - e. Parker (Parker Hannifin).
 - f. RectorSeal HVAC; a CSW Industrials Company.
 - g. Refrigeration Sales, Inc.
2. Body: Forged brass with brass cap, including key end to remove core.
3. Core: Removable ball-type check valve with stainless steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

E. Refrigerant Locking Caps:

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

- a. C & D Valve, LLC.
 - b. JB Industries.
 - c. RectorSeal HVAC; a CSW Industrials Company.
 - d. Refrigeration Sales, Inc.
 2. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant-charging ports from unauthorized refrigerant access and leakage.
 3. Material: Brass, with protective shroud or sleeve.
 4. Refrigerant Identification: Color-coded, refrigerant specific based on AHRI Guideline N design.
 5. Special Tool: For installing and unlocking.
- F. Solenoid Valves: Comply with AHRI 760 I-P and UL 429; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
 - d. Parker (Parker Hannifin).
 2. Body and Bonnet: Plated steel.
 3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 4. Seat: Polytetrafluoroethylene.
 5. End Connections: Threaded.
 6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24, 115, or 208 V ac coil as required by equipment manufacturer.
 7. Working Pressure Rating: 400 psig.
 8. Maximum Operating Temperature: 240 deg F.
- G. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker (Parker Hannifin).
 2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 3. Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Seat: Polytetrafluoroethylene.
 5. End Connections: Threaded.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
- H. Thermostatic Expansion Valves: Comply with AHRI 750 I-P.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
 - d. Parker Hannifin; Sporlan Division (Zoomlock).

2. Body, Bonnet, and Seal Cap: Forged brass or steel.
 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 6. Suction Temperature: 40 deg F.
 7. Superheat: Adjustable or Nonadjustable as required by equipment manufacturer.
 8. Reverse-flow option (for heat-pump applications).
 9. End Connections: Socket, flare, or threaded union.
 10. Working Pressure Rating: 700 psig or 450 psig as required by equipment manufacturer.
- I. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker (Parker Hannifin).
 2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 6. Seat: Polytetrafluoroethylene.
 7. Equalizer: Internal or External as required by the equipment manufacturer.
 8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 24, 115, or 208 V ac coil as required by equipment manufacturer.
 9. End Connections: Socket.
 10. Set Pressure: as required by equipment manufacturer.
 11. Throttling Range: Maximum 5 psig.
 12. Working Pressure Rating: 500 psig.
 13. Maximum Operating Temperature: 240 deg F.
- J. Straight-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker (Parker Hannifin).
 2. Body: Welded steel with corrosion-resistant coating.
 3. Screen: 100-mesh stainless steel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- K. Angle-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker (Parker Hannifin).

2. Body: Forged brass or cast bronze.
3. Drain Plug: Brass hex plug.
4. Screen: 100-mesh monel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

L. Moisture/Liquid Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
 - d. Parker (Parker Hannifin).
 - e. RLS LLC.
2. Body: Forged brass.
3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color-coded to show moisture content in parts per million (ppm).
5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
6. End Connections: Socket or flare.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

M. Replaceable-Core Filter Dryers: Comply with AHRI 730 I-P.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
 - d. Parker (Parker Hannifin).
2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
4. Desiccant Media: Activated alumina or charcoal as required by equipment manufacturer.
5. Design: Reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Rated Flow: as required by equipment manufacturer.
10. Working Pressure Rating: 500 psig.

11. Maximum Operating Temperature: 240 deg F.

N. Permanent Filter Dryers: Comply with AHRI 730 I-P.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
 - d. Parker (Parker Hannifin).
 - e. RLS LLC.
2. Body and Cover: Painted-steel shell.
3. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
4. Desiccant Media: Activated alumina or charcoal as required by equipment manufacturer.
5. Design: Reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Rated Flow: as required by equipment manufacturer.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

O. Mufflers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss, Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
 - d. Parker Hannifin; Sporlan Division (Zoomlock).
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

P. Receivers: Comply with AHRI 495.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Henry Technologies Inc.; The Henry Group.
 - b. Parker Hannifin; Sporlan Division (Zoomlock).
2. For receivers larger than 6 inches, comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
3. Comply with UL 207; listed and labeled by an NRTL.
4. Body: Welded steel with corrosion-resistant coating.
5. Tappings: Inlet, outlet, liquid-level indicator, and safety-relief valve.
6. End Connections: Socket or threaded.

7. Working Pressure Rating: 450 psig.
8. Maximum Operating Temperature: 250 deg F.

Q. Liquid Accumulators: Comply with AHRI 495.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Emerson Climate Technologies; Emerson Electric Co.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker (Parker Hannifin).
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

A. R-454B, ASHRAE 34: R-32/1234yf, blend.

B. R-410A, ASHRAE 34: Pentafluoroethane/Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arkema Inc.
 - b. DuPont Fluorochemicals Div.
 - c. Genetron Refrigerants; Honeywell International Inc.
 - d. Mexichem Fluor, Inc. (Koura).

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

- A. Refrigerant: R-410A or R-454B
- B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, 1-1/2 inch and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, 2 to 4 inch: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Safety-Relief-Valve Discharge Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, Copper: Type ACR, drawn-temper or annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- E. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, 1-1/2 inch and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

- F. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, 2 to 4 inch: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- G. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type ACR, drawn-temper or annealed-temper tubing and wrought-copper fittings with brazed or soldered joints

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install valve and specialty applications as required by equipment manufacturers.

3.3 INSTALLATION OF PIPING, GENERAL

- A. Install per manufacturers requirements. Equipment manufacturers shall size all piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. This is a delegated design to be completed by the contractor and manufacturer of the VRF system. Install piping as indicated on Shop Drawings provided by the manufacturer of the equipment.
- C. Install refrigerant piping in accordance with ASHRAE 15.
- D. Refrigerant piping shall not be installed in any of the following locations:
 - 1. Exposed within a fire-resistance -rated exit access corridor.
 - 2. Exposed within an interior exit stairway.
 - 3. Within an interior exit ramp.
 - 4. Within an exit passageway.
- E. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise. Refrigerant piping shall be installed so as to prevent strains and stresses that exceed the structural strength of the pipe.
- G. Shield Plates: Shield plates shall be of steel material having a thickness of not less than 0.0575 inches.
- H. Exposed piping having surface temperatures greater than 120 degrees F or less than 5 degrees F with ready access to non-authorized personnel shall be protected from contact or shall have thermal insulation that limits the exposed insulation surface temperature to a range of 5 degrees F to 120 degrees F.
- I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- J. Install piping adjacent to machines to allow service and maintenance.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.

- M. Select system components with pressure rating equal to or greater than system operating pressure.
- N. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and drawings for solenoid valve controllers, control wiring, and sequence of operation.
- O. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- P. Arrange piping to allow inspection and service of refrigeration 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.
- Q. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- R. Slope refrigerant piping in accordance with equipment manufacturer requirements.
- S. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- U. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment." For Group A2L refrigerants, the identification shall also include the following statement: "WARNING-Risk of Fire. Flammable Refrigerant."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook."
- D. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.

2. Use Type BA_g (cadmium-free silver) alloy for joining copper with bronze or steel.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- B. Install the following pipe attachments:
 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 ft. long.
 2. Roller hangers and spring hangers for individual horizontal runs 20 ft. or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches of each fitting.
- E. Support vertical runs of copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 1. Refrigerant piping systems that are erected in the field shall be pressure tested for strength and leak tested for tightness, in accordance with ASHRAE Standard 15 after installation and before being placed in operation. Test shall include both high- and low-pressure sides of each system.
 2. Exposure of refrigerant piping system. Refrigerant pipe and joints installed in the field shall be exposed for visual inspection and testing prior to being covered or enclosed.
 3. Field test gases. The medium used for field pressure testing the refrigeration system shall be one of the following inert gasses: oxygen-free nitrogen, helium, argon or premixed nonflammable oxygen-free nitrogen with a tracer gas of hydrogen or helium. Oxygen, air, refrigerants, combustible gases and such mixtures shall not be used.
 4. Test apparatus. The means used to pressurize the refrigerant piping system shall have on its outlet side a test pressure measuring device and either a pressure-limiting device or a pressure-reducing device. The test pressure measuring device shall have an accuracy of ± 3 percent or less of the test pressure and shall have a resolution of 5 percent or less of the test pressure.
 5. Piping system strength test. Refrigeration system components and refrigerant piping shall be tested in accordance with ASME B31.5. Separate tests for isolated portions of the system are permitted, provided that all required portions are tested at least once. Pressurize with test gas for a minimum of 10 minutes to not less than the lower of (a) the lowest design pressure for any system component or (b) the lowest value of set pressure

for any pressure relief devices in the system. The design pressures for determination of test pressure shall be the pressure identified on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. A passing test result shall have no rupture or structural failure of any system component or refrigerant piping. Refrigerant piping and tubing greater than $\frac{3}{4}$ inch in diameter shall be tested in accordance with ASHRAE 15.

- C. Prepare test and inspection reports. The installing contractor shall issue a certificate of test to the code official for all refrigeration systems containing 55 pounds or more of refrigerant. The certificate shall give the test date, name of the refrigerant, test medium and the field test pressure applied to the high-pressure side and the low-pressure side of the refrigeration system. The certification of test shall be signed by the installing contractor shall be made of the public record.

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Verify that compressor oil level is correct.
 - 2. Open compressor suction and discharge valves.
 - 3. Open refrigerant valves but not bypass valves that are used for other purposes.
 - 4. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - 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.

B. Related Requirements:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. 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.

C. 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.
5. Design Calculations: Calculations for selecting 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.
- B. Welding certificates.
- C. Field quality-control reports.

1.4 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 D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Duct Liner
 1. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training. Preference will be given to those who have successfully completed a manufacturer's installation training program.
 2. Inspection: A certified mechanical insulation shall be performed by inspectors who maintain current certification, by the National Insulation Association or other certified mechanical association, throughout the project to inspect and verify the materials and the total insulation system has been installed correctly in accordance with the specifications and material manufacturer's instructions.
 3. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products listed and labeled in accordance with UL 723 or tested in accordance with ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.1 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" ASCE/SEI 7.
- C. Wind Performance: Ducts are to withstand the effects of wind determined in accordance with ASCE/SEI 7.
- D. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- F. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- G. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 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 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.
- 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.
- 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.
- 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."

2.3 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 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.
 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Linx Industries; a DMI company (formerly Lindab).
 - b. MKT Metal Manufacturing.
 - c. McGill AirFlow LLC.
 - d. SEMCO, LLC; part of FlaktGroup.
 - e. SHAPE Manufacturing Inc.
 - f. Sheet Metal Connectors, Inc.
 - g. Ductmate Industries, Inc; a DMI company.
- 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."

2.4 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. 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.
- D. Factory- or Shop-Applied Antimicrobial Coating:
 - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating is to be applied to the exterior surface.
 - 2. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Coating containing the antimicrobial compound is to have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
 - 4. 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.
 - 5. Shop-Applied Coating Color: Black.
 - 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- E. 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.
- F. Tie Rods: Galvanized steel, 1/4-inch-minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

2.5 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, provide products by one of the following:
 - a. CertainTeed; SAINT-GOBAIN.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 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.
- B. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-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.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. 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.

2.6 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 sheets.
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. 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. 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.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. 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.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- D. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.
- E. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. 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.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for 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 in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- K. Install 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 wherever they fit.
 - 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.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCTWORK EXPOSED TO WEATHER

- A. All external joints are to be welded or be scheduled to be externally insulated. Seal all openings to provide weatherproof construction.
- B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.
- C. Single Wall:

1. Insulated Ductwork can be galvanized steel.
2. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

3.4 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."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 DUCTWORK CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099123 "Interior Painting."

3.8 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. Supply or Outdoor Air Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - b. Return or Exhaust Air Ducts with a Pressure Class of 3-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, 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. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.9 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air and Exhaust-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air and Outdoor-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.

3.10 STARTUP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 - 1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
- B. Supply Ducts (including Outdoor Air Ducts from DOAS Units):
 - 1. Ducts Connected to Fan Coil Units and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round: 4.
 - 2. Ducts Connected to DOAS Units:
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round: 2.
 - 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round: 2.
- C. Return Ducts (including Exhaust Air Ducts to+ DOAS Units):
 - 1. Ducts Connected to Fan Coil Units and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round: 4.
 - 2. Ducts Connected to DOAS Units:
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round: 2.
 - 3. Ducts Connected to Equipment Not Listed above:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 4.
 - d. SMACNA Leakage Class for Round: 2.
- D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round: 4.
- E. Intermediate Reinforcement:
 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
- F. Liner:
 1. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.
- G. Elbow Configuration:
 1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

- 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
- 4) Radius-to Diameter Ratio: 1.5.

- b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

H. 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 spin in.
- 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft dampers.
2. Manual volume dampers.
3. Fire dampers.
4. Flange connectors.
5. Turning vanes.
6. Remote damper operators.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Duct accessory hardware.

B. Related Requirements:

1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.
2. Section 284621 "Addressable Fire-Alarm Systems" for duct-mounted smoke detectors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Fire-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - d. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

- B. 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 BACKDRAFT DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc. Model CBD6/CD60
 - 2. American Warming and Ventilating (AWV); Mestek, Inc.
 - 3. Cesco Products; MESTEK, Inc.
 - 4. Greenheck Fan Corporation.
 - 5. Nailor Industries Inc.
 - 6. Vent Products Co., Inc.
- B. Description: Gravity balanced.
- C. Performance:
 - 1. Maximum Air Velocity: 2000 fpm.
 - 2. Maximum System Pressure: 2 inches wg.
 - 3. Leakage:
 - a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
- D. Construction:

1. Frame:
 - a. Hat shaped.
 - b. 16-gauge- thick, galvanized sheet steel, with welded or mechanically attached corners and mounting flange.
2. Blades:
 - a. Multiple single-piece blades.
 - b. Center pivoted, maximum 6-inch width, 0.050-inch- thick aluminum sheet with sealed edges.
3. Blade Action: Parallel.
- E. Blade Seals: Felt or Neoprene, mechanically locked.
- F. Blade Axles:
 1. Material: Galvanized steel.
 2. Diameter: 0.20 inch.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Return Spring: Adjustable tension.
- I. Bearings: Steel ball or synthetic pivot bushings.
- J. Accessories:
 1. Adjustment device to permit setting for varying differential static pressure.
 2. Counterweights and spring-assist kits for vertical airflow installations.
 3. Chain pulls.
 4. Screen Mounting:
 - a. Rear mounted in sleeve.
 - 1) Sleeve Thickness: 20 gauge minimum.
 - 2) Sleeve Length: 6 inches minimum.
 5. Screen Material: Galvanized steel.
 6. Screen Type: Bird.
 7. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc. Model CD36
 - b. Air Balance; MESTEK, Inc.

- c. American Warming and Ventilating (AWV); Mestek, Inc.
 - d. Arrow United Industries; Mestek, Inc.
 - e. Cesco Products; MESTEK, Inc.
 - f. Greenheck Fan Corporation.
 - g. McGill AirFlow LLC.
 - h. Nailor Industries Inc.
 - i. Vent Products Co., Inc.
 - 2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
 - 3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 - 4. Frames:
 - a. Hat-shaped, 16-gauge- thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel; 16 gauge thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 - 8. Tie Bars and Brackets: Galvanized steel.
 - 9. Locking device to hold damper blades in a fixed position without vibration.
- B. Low-Leakage, Steel, Manual Volume Dampers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc. Model CD60
 - b. Air Balance; MESTEK, Inc.
 - c. American Warming and Ventilating (AWV); Mestek, Inc.
 - d. Arrow United Industries; Mestek, Inc.
 - e. Cesco Products; MESTEK, Inc.
 - f. Greenheck Fan Corporation.
 - g. McGill AirFlow LLC.
 - h. Nailor Industries Inc.
 - i. Vent Products Co., Inc.

2. Performance:
 - a. AMCA Certification: Test and rate in accordance with AMCA 511.
 - b. Leakage:
 - 1) Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
 3. Construction:
 - a. Linkage: Out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 4. Frames:
 - a. Hat, U, or angle shaped.
 - b. Thickness: 16-gauge galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel; 16 gauge thick.
 6. Blade Edging Seals:
 - a. Closed-cell neoprene.
 7. Blade Jamb Seals: Neoprene.
 8. Blade Axles: Galvanized steel.
 9. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
 10. Tie Bars and Brackets: Galvanized steel.
 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.

2.4 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc. Model IBD (static) and DIBD (dynamic)
 2. Air Balance; MESTEK, Inc.
 3. Arrow United Industries; Mestek, Inc.
 4. Cesco Products; MESTEK, Inc.
 5. Greenheck Fan Corporation.
 6. Vent Products Co., Inc.
- B. Type: Static and dynamic; rated and labeled in accordance with UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.
- D. Fire Rating: 1-1/2 and 2 hours.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed galvanized sheet steel, interlocking. In place of interlocking blades, full-length steel blade connectors. Material gauge is to be in accordance with UL listing.
- I. Horizontal Dampers: Include blade lock and stainless steel closure spring.
- J. Heat-Responsive Device:
1. Replaceable, 165 deg F rated, fusible links.

2.5 FLANGE CONNECTORS

- 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. DynAir; a Carlisle Company.
 4. Elgen Manufacturing.
 5. Ward Industries; a brand of Hart & Cooley, LLC.

- B. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gauge and Shape: Match connecting ductwork.

2.6 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aero-Dyne Sound Control Co.
 - 2. CL WARD & Family Inc.
 - 3. Ductmate Industries, Inc; a DMI company.
 - 4. Duro Dyne Inc.
 - 5. DynAir; a Carlisle Company.
 - 6. Elgen Manufacturing.
 - 7. Ward Industries; a brand of Hart & Cooley, LLC.
- B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. 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."
- D. Vane Construction:
 - 1. Single or double wall.
 - 2. Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.7 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. DynAir; a Carlisle Company.
 - 2. METALAIRE, Inc.
 - 3. United Enertech Corp.
 - 4. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.

- E. Wall-Box Mounting: Surface.
- F. Wall-Box Cover-Plate Material: Steel.

2.8 DUCT-MOUNTED ACCESS DOORS

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

- 1. Arrow United Industries; Mestek, Inc.
- 2. Cesco Products; MESTEK, Inc.
- 3. Ductmate Industries, Inc; a DMI company.
- 4. Duro Dyne Inc.
- 5. Flexmaster U.S.A., Inc.
- 6. McGill AirFlow LLC.
- 7. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.
- 8. Ventfabrics, Inc.
- 9. Ward Industries; a brand of Hart & Cooley, LLC.

- 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 door panel to match duct construction.
 - 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.
- 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.9 FLEXIBLE CONNECTORS

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

- 1. Ductmate Industries, Inc; a DMI company.
- 2. Duro Dyne Inc.

3. Ventfabrics, Inc.
 4. 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 .
- 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. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- I. 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.

2.10 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. Hardcast; Carlisle Construction Materials.
7. United Enertech Corp.
8. Ventfabrics, Inc.
9. 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.

2.11 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.
 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and match installed duct finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts;.
- F. 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 3 - EXECUTION

3.1 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 ducts.
- C. Install backdraft 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.
 - 1. Install steel volume dampers in steel ducts.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
- H. Install fire dampers in accordance with UL listing.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. At outdoor-air intakes plenums.
 - 2. At drain pans and seals.
 - 3. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 4. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire 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.
 - 5. At each change in direction and at maximum 50-ft. spacing.
 - 6. Upstream and downstream from turning vanes.
 - 7. Control devices requiring inspection.
 - 8. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. 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.
- L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. Install duct test holes where required for testing and balancing purposes.

- O. 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.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire 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.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Flexible ducts, insulated.
 - 2. Flexible duct connectors.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Flexible ducts, insulated.
 - 2. Flexible duct connectors.
- B. Product Data Submittals: For each type of product.
- C. Shop Drawings: For flexible ducts.
 - 1. Include plans showing locations, mounting details, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Comply with the Air Duct Council's (formerly, Air Diffusion Council) "ADC Flexible Air Duct Test Code - FD 72-R1" and "Flexible Duct Performance & Installation Standards."
- D. Comply with ASTM E96/E96M.

2.2 FLEXIBLE DUCTS, INSULATED

- A. Standard: Product is to be UL 181 listed and bearing the UL label.
- B. Flexible Ducts, Insulated - Class 1, Two-Ply Vinyl Film Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ATCO Rubber Products, Inc.
 - b. Flexmaster U.S.A., Inc.
 - c. JP Lamborn Co.
 - d. Thermaflex; a Flex-Tek Group company.
 - 2. Pressure Rating: 10 inch wg positive and 1.0 inch wg negative.
 - 3. Maximum Air Velocity: 4000 fpm.
 - 4. Temperature Range: Minus 10 to plus 160 deg F.
 - 5. Insulation R-Value: R8.
 - 6. Vapor-Barrier Film: Polyethylene.

2.3 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless steel band with stainless steel or zinc-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
- B. Non-Clamp Connectors: Liquid adhesive plus tape.

PART 3 - EXECUTION

3.1 INSTALLATION OF FLEXIBLE DUCTS

- A. Install flexible ducts in accordance with applicable details in the following publications:
 - 1. ADC's "Flexible Duct Performance & Installation Standards" for flexible ducts.
 - 2. NAIMA AH116.
 - 3. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install in indoor applications only. Do not install flexible duct in locations where it will be exposed to UV lighting.
- C. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- D. Connect flexible ducts to metal ducts with draw bands.
- E. Installation:
 - 1. Install ducts fully extended.
 - 2. Do not bend ducts across sharp corners.
 - 3. Bends of flexible ducting must 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.
6. Install in accordance with ADC instructions.

F. Supporting Flexible Ducts:

1. Support flexible duct at manufacturer's recommended intervals, but at no greater distance than 4 ft.. Provide sufficient support so that maximum centerline sag is 1/2 in. per ft. between supports. A connection to rigid duct or equipment may be considered a support joint.
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 must not exceed the maximum spacing in accordance with manufacturer's written installation instructions.
4. Vertically installed ducts must be stabilized by support straps at a maximum of 72 inches o.c.
5. Provide duct elbow support at locations where an elbow connection is provided. Provide sheet metal elbow at locations where an elbow connection is specified.

END OF SECTION 233346

SECTION 233413 - FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Square in-line centrifugal fans.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - 2. Include rated capacities, furnished specialties, and accessories for each fan.
 - 3. 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 and electrical characteristics, plus motor and electrical accessories.
 - e. Fan speed controllers.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Startup service reports.
- C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans, include the following:

1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Capacities: See mechanical equipment schedule on drawings.

F. Fans shall be:

1. Catalog rated for 15 percent greater static pressure than specified at specified air volume.
2. Selected so that the specified air volume is greater than that at the apex of the fan pressure volume curve.

3. Selected to provide stable operation down to 85 percent of design volume operating at the required speed for the specified conditions. Brake horsepower at specified duty for airfoil and backward inclined bladed centrifugal fans shall not exceed 78 percent of motor nameplate horsepower times the NEMA service factor and for forward curved bladed centrifugal fans shall not exceed 70 percent of motor nameplate horsepower times the NEMA service factor.

G. Capacities and Characteristics: Duty indicated on the drawings.

2.2 SQUARE IN-LINE CENTRIFUGAL FANS

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

1. Acme Engineering & Manufacturing Corp.
2. Aerovent; a division of Twin City Fan Companies, Ltd.
3. American Coolair Corporation.
4. Greenheck Fan Corporation.
5. JencoFan.
6. Loren Cook Company.
7. PennBarry; division of Air System Components.
8. S & P USA Ventilation Systems, LLC.
9. Twin City Fan Company.

B. Description: Square housing in-line centrifugal fans.

C. Standards: Comply with UL 705.

D. Housing:

1. Housing Material: Reinforced steel.
2. Housing Coating: Powder-baked enamel.
3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

E. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

F. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

G. Motor Enclosure: Open, dripproof.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

2.4 SOURCE QUALITY CONTROL

- A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311./ISO 13347 – Determination of fan sound power levels under standardized laboratory conditions.
- B. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
 - 1. Support duct-mounted and other hanging fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."
- E. Install units with adequate clearances for service and maintenance.
- F. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- B. Ground equipment in accordance with Section 260526 "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.
- E. Install power wiring to field-mounted electrical devices, furnished by fan manufacturer, but not factory mounted.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE:

- A. Perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Lubricate bearings.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Fan 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.
 - 3. Fans and components will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC fans.

END OF SECTION 233413

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Modulating, single-duct air terminal units.
 2. Exhaust single-duct terminal units.
 3. Casing liner.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air terminal units.
1. Include plans, elevations, sections, and mounting 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.
 4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Documents," include the following:
 - a. Instructions for resetting minimum and maximum air volumes.
 - b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.
- B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
 - 2. Carnes Company.
 - 3. METALAIRE, Inc.
 - 4. Nailor Industries Inc.
 - 5. Price Industries Limited.
 - 6. Titus; brand of Johnson Controls International plc, Global Products.
 - 7. Trane.
- B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: Minimum 22-gauge-thick galvanized steel.
 - 1. Casing Liner: Comply with requirements in "Casing Liner" Article below for "Casing Liner, Flexible Elastomeric" Paragraph.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- E. Velocity Sensors: Multipoint array with velocity inlet sensors.
- F. Attenuator Section
 - 1. Sound: The manufacturer shall furnish certified sound power levels, and associated noise criteria (NC) levels for both discharge and radiated sound. Tested in accordance with the most current ASHRAE Standards and AHRI Standard 880. The tests shall be conducted in an AHRI-ADC approved sound facility. The following sound adjustment

factors shall be utilized for each terminal unit to determine resulting sound levels within the occupied spaces:

DB Reduction (2 nd thru 7 th octave bands)						
	2	3	4	5	6	7
Discharge: 5 inch or less inlet	16	12	9	7	8	9
Discharge: 6-inch inlet and larger	18	13	11	10	11	12
Radiated	17	18	19	25	30	33

2. The above attenuation values include environmental adjustment factor, branch power division, end reflection, space effect, ceiling tile loss, etc. Additional attenuation factors shall not be used and will not be accepted. Where fiberglass lined ductwork is indicated on the drawings, attenuation reduction values indicated in the most current version of AHRI Standard 885 can be utilized up to a maximum length of five feet of lined ductwork. Where flexible ductwork is indicated on the drawings, attenuation reduction values indicated in the most current version of AHRI Standard 885 can be utilized up to a maximum length of three feet. .
3. Use NC-35 and use 1.0 inches WG inlet pressure. Where required, provide sound attenuators for discharge noise control. For radiated noise, attach 3.5-inch batt insulation to the top of the ceiling tile for a 15 foot radius from the terminal unit.

G. Direct Digital Controls:

1. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controllers, integrated actuators, and room sensors to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC."

H. Control Sequence: See Drawings for control sequences.

2.3 EXHAUST SINGLE-DUCT TERMINAL UNITS

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

1. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
2. Nailor Industries Inc.
3. Price Industries Limited.
4. Titus; brand of Johnson Controls International plc, Global Products.

B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud, for exhaust applications where pressurization control via exhaust and supply airflow control is desired.

C. Casing: Minimum 22-gauge-thick galvanized steel.

1. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
2. Air Outlet: S-slip and drive connections.

3. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- E. Attenuator Section
1. Sound: The manufacturer shall furnish certified sound power levels, and associated noise criteria (NC) levels for both discharge and radiated sound. Tested in accordance with the most current ASHRAE Standards and AHRI Standard 880. The tests shall be conducted in an AHRI-ADC approved sound facility. The following sound adjustment factors shall be utilized for each terminal unit to determine resulting sound levels within the occupied spaces:

DB Reduction (2 nd thru 7 th octave bands)						
	2	3	4	5	6	7
Discharge: 5 inch or less inlet	16	12	9	7	8	9
Discharge: 6-inch inlet and larger	18	13	11	10	11	12
Radiated	17	18	19	25	30	33

2. The above attenuation values include environmental adjustment factor, branch power division, end reflection, space effect, ceiling tile loss, etc. Additional attenuation factors shall not be used and will not be accepted. Where fiberglass lined ductwork is indicated on the drawings, attenuation reduction values indicated in the most current version of AHRI Standard 885 can be utilized up to a maximum length of five feet of lined ductwork. Where flexible ductwork is indicated on the drawings, attenuation reduction values indicated in the most current version of AHRI Standard 885 can be utilized up to a maximum length of three feet.
 3. Use NC-35 when noise criteria and use 1.0 inches WG inlet pressure. Where required, provide sound attenuators for discharge noise control. For radiated noise, attach 3.5-inch batt insulation to the top of the ceiling tile for a 15 foot radius from the terminal unit.
- F. Direct Digital Controls:
1. Terminal Unit Controller, Section 230923: Controller is to be factory mounted and wired by air terminal manufacturer; unit controller, actuators, and room sensors are to be furnished under Section 230923 "Direct Digital Control (DDC) System for HVAC." Damper Actuator: 24 V, spring-return open.
- G. Control Sequence: See Drawings for control sequences.

2.4 CASING LINER

- A. Casing Liner, Flexible Elastomeric: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - 1. Minimum Thickness: 1 inch.
 - 2. 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.
 - 3. 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.

2.5 SOURCE QUALITY CONTROL

- A. AHRI 880 Certification: Test, rate, and label assembled air terminal units in accordance with AHRI 880.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.
- B. Install air terminal units according to NFPA 90A.
- C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 DUCTWORK CONNECTIONS

- A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

- A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.
- B. Provide disconnect switch.
- C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- D. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Division 26. Section 260523 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

- A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.7 ADJUSTING

- A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- B. Air terminal unit will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Square ceiling diffusers.
2. Linear slot diffusers.
3. High-capacity drum louver diffusers.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire dampers and volume-control dampers not integral to diffusers.
2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 SQUARE CEILING DIFFUSERS

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

1. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
2. Carnes Company.
3. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Price Industries Limited.
7. Titus; brand of Johnson Controls International plc, Global Products.
8. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.

B. Type D-1, Titus TMS

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Size: as indicated on drawings.
5. Face Style: Three cone.
6. Mounting: T-bar.
7. Pattern: Fixed 360 degree pattern
8. Dampers: Radial opposed blade adjustable via screwdriver without removing inner cone.
9. Accessories:
 - a. Sectionalizing baffels.

2.2 LINEAR SLOT DIFFUSERS

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

1. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
2. Carnes Company.
3. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Price Industries Limited.
7. Titus; brand of Johnson Controls International plc, Global Products.
8. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.

B. Type D-3, Titus MP/ML

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material - Shell: Steel, insulated.
3. Material - Pattern Controller and Tees: Aluminum.
4. Finish - Face and Shell: Baked enamel, black.
5. Finish - Pattern Controller: Baked enamel, black.
6. Finish - Tees: Baked enamel, white.

7. Slot Width: as scheduled on drawings.
8. Number of Slots: as scheduled on drawings.
9. Length: as scheduled on drawings.
10. Insulated Plenum: Insulated plenums shall be designed specifically for field attachment to the linear slot diffuser. Plenums shall include a factory drawn side inlet to fit the slot diffuser of the sizes and mounting types shown on the plans. Length shall match slot. The performance data with the linear slot diffuser and plenum shall be tested as one assembly in accordance with -ANSI/ASHRAE Standard 70.
11. Plenum Inlet Size: Connection to match duct size indicated on drawings.
12. Plenum End Caps: End caps are not insulated and can be turned up in the field to allow installing continuous lengths beyond the standard maximum length of 6 feet.
13. Border Type: border type shall be continuous including end caps and end border to match frame. Frame and border type shall be either exposed mounting or for lay-in as required for the installed ceiling type.

2.3 HIGH-CAPACITY DRUM LOUVER DIFFUSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
 2. Carnes Company.
 3. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
 4. METALAIR, Inc.
 5. Nailor Industries Inc.
 6. Price Industries Limited.
 7. Titus; brand of Johnson Controls International plc, Global Products.
 8. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
- B. Type D-2, Titus TND-AA
1. Airflow Principle: Extended distance for high airflow rates.
 2. Material: Aluminum, heavy gage extruded.
 3. Finish: White.
 4. Body: Drum shaped; with minimum 75 degree of global rotation. 38-degree rotation in any one direction from center.
 5. Mounting: Surface to wall.
 6. Size: as scheduled on the drawings.
 7. Damper: aluminum aperture damper with stainless steel hardware shall be operable from the face of the nozzle, the damper shall provide a full range of 0 to 100% airflow.

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

2.5 CODES AND STANDARDS

- A. ASHRAE Standard 70, Method of Testing the Performance of Air Outlets and Air Inlets, 2006.

- B. ASTM Standard E84, Standard Test Method for Surface Burning Characteristics of Building Materials, 2016.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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.

3.3 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Registers
2. Grilles

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Perforated - Type R-1, Titus PAR

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
 - b. Carnes Company.
 - c. Hart & Cooley, LLC.
 - d. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Price Industries Limited.
 - h. Titus; brand of Johnson Controls International plc, Global Products.
 - i. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel backpan and pattern controllers, with steel face.
4. Finish: Baked enamel, white.
5. Face Size: as indicated on drawings.
6. Duct Inlet: as indicated on drawings.
7. Face Style: Flush.
8. Mounting: T-bar.
9. Pattern Controller: None.
10. Dampers: Opposed blade.

2.2 GRILLES

A. Perforated Grilles- Type G-1, Titus PAR

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Air Distribution; Anemostat, Inc.; Mestek, Inc.
 - b. Carnes Company.
 - c. Hart & Cooley, LLC.
 - d. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Price Industries Limited.
 - h. Titus; brand of Johnson Controls International plc, Global Products.
 - i. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel backpan and pattern controllers, with steel face.
4. Finish: Baked enamel, white.
5. Face Size: as indicated on drawings.
6. Duct Inlet: as indicated on drawings.
7. Face Style: Flush.
8. Mounting: T-bar.
9. Pattern Controller: None.
10. Dampers: None.

B. Linear Slot Grilles – Type G-2, Same as linear slot diffusers in specification Section 233713.13 Air Diffusers.

C. Perforated Grille with Filter - Type G-3, Titus 8RF

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hart & Cooley, LLC.
 - b. METALAIRE, Inc.
 - c. Nailor Industries Inc.
 - d. Price Industries Limited.
 - e. Titus; brand of Johnson Controls International plc, Global Products.
 - f. Tuttle & Bailey; brand of Johnson Controls International plc, Global Products.
2. Grille shall be provided with a filter frame for a standard 2-inch filter to fit the specified duct size.
3. Hinge: Top
4. Material: Face and border shall be constructed of perforated steel with 3/16-inch diameter holes on ¼ inch staggered centers to provide 51 percent free area.
5. Outer Borders: 1¼ inches wide.
6. Corners: assembled with full penetration resistance welds with a reinforcing patch for extra strength.
7. Screw Holes: Countersunk.
8. Finish: Baked enamel, white.
9. Face Size: as indicated on drawings.
10. Duct Inlet: as indicated on drawings.
11. Face Style: Flush.
12. Mounting: T-bar.
13. Pattern Controller: None.
14. Dampers: None.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: 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 registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 235123 - GAS VENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Listed double-wall vents.

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 product.
- B. Shop Drawings: For vents.
 - 1. Include plans, elevations, sections, 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. Detail fabrication and assembly of hangers and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Sample Warranty: For special warranty.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents.
- B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 LISTED TYPE B AND BW VENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Metal Products.
 - 2. Cleaver-Brooks.
 - 3. DuraVent.
 - 4. FAMCO.
 - 5. Hart & Cooley, LLC.
 - 6. Heatfab Saf-T Vent.
 - 7. Industrial Chimney Company.
 - 8. LSP Products Group.
 - 9. Metal-Fab, Inc.
 - 10. Schebler Co. (The).
 - 11. Jeremias Inc.
- B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch airspace.
- D. Inner Shell: ASTM A666, Type 430 stainless steel.
- E. Outer Jacket: Galvanized steel.
- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Listed Type B and BW Vents: Vents for certified gas appliances.

3.3 INSTALLATION OF LISTED VENTS

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
- B. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- C. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- E. Lap joints in direction of flow.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 235123

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes factory-assembled, dedicated outdoor air-handling units, including multiple components, capable of heating and cooling 100 percent outdoor air.

1.2 ACTION SUBMITTALS

- A. Product Data: For each dedicated outdoor-air unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Include unit dimensions and weight.
 - 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 - 5. 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.
 - 6. Include certified coil-performance ratings with system operating conditions indicated.
 - 7. Include filters with performance characteristics.
 - 8. Include heat exchangers with performance characteristics.
 - 9. Include dampers, including housings, linkages, and operators.
- B. Shop Drawings: For each dedicated outdoor-air unit.
 - 1. Include plans, elevations, sections, and mounting 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor/roof plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Sample Warranty: For manufacturer's warranty.
- C. Product Certificates: Submit certification that specified equipment will withstand wind forces. identified in in Section 230548 "Vibration Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Source quality-control reports.
- E. Startup service reports.
- F. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, 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. Filters: One set(s) for each unit.
 2. Gaskets: One set(s) for each access door.

1.6 WARRANTY

- A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Dedicated Outdoor-Air-Handling Units: Five years from date of Substantial Completion.
 2. Warranty Period for Compressors: Five years from date of Substantial Completion.
 3. Warranty Period for Heat Exchangers: 10 years from date of Substantial Completion.
 4. Warranty Period for Rotary Heat Exchangers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. ASHRAE 84 Compliance: Comply with capacity ratings for heat-wheel energy-recovery equipment.
- G. UL Compliance:
 - 1. Electric Coils: Comply with requirements in UL 1995.
- H. Wind-Restraint Performance:
 - 1. See Section 230548 "Vibration Controls for HVAC" for requirements.

2.2 CAPACITIES AND CHARACTERISTICS

- A. As scheduled on the drawings.

2.3 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Innovent
 - 2. Trane (Basis of Design)
 - 3. Valent
- B. Source Limitations: Obtain dedicated outdoor-air units from single manufacturer.

2.4 UNIT CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Configuration: Horizontal unit with bottom (as indicated on drawings) discharge for roof-mounting installation.
- C. Double-Wall Configuration:
 - 1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with corrosion-resistant coating, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 2. Inside Casing Wall:
 - a. Galvanized steel, solid.

- b. Antimicrobial Coating: Applied during the manufacturing process. Coating is to be EPA approved.
 - 3. Floor Plate: Reinforced metal surface; reinforced to limit deflection when walked on by service personnel. Insulation is provided below metal walking surface.
 - 4. Roof: Standing seam or membrane; sloped to drain water.
 - 5. Casing Insulation:
 - a. Materials: Polyurethane foam insulation.
 - b. Casing Panel R-Value: Minimum R-13.
 - c. Insulation Thickness: 2 inches.
 - d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
- D. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- E. Static-Pressure Classifications:
 - 1. For Unit Sections Upstream of Fans: Minus 3 inches wg.
 - 2. For Unit Sections Downstream and Including Fans: 3 inches wg.
- F. Doors:
 - 1. Doors:
 - a. Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.
 - 2. Locations and Applications:
 - a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Damper Section: Doors.
 - d. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - e. Relief Section: Doors.
- G. Condensate Drain Pans:
 - 1. Location: Each refrigerant coil and rotary heat exchanger.
 - 2. Construction:
 - a. Single-wall, stainless steel sheet.
 - 3. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.

4. Drain Connection:
 - a. Located on one end of pan, at lowest point of pan.
 - b. Terminated with threaded nipple.
 - c. Minimum Connection Size: 1 inch.
5. Slope: Minimum 0.125-inch/ft. slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
6. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
7. Width: Entire width of water-producing device.
8. Depth: A minimum of 2 inches deep.
9. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.

2.5 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans and Relief-Air Fans: Centrifugal; galvanized or painted steel; mounted on solid-steel shaft with piezometer airflow measuring rings.
 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours in accordance with ABMA 9.
 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 4. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
 5. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
 6. Mounting: For internal vibration isolation. Factory mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 2 inches.
 7. Shaft Lubrication Lines: Extended to a location outside the casing.
 8. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch- wide by 0.028-inch- thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

- C. Drive, Direct: Factory-mounted direct drive.
- D. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated motors.
- E. Motors:
 - 1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
 - 2. 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.
 - 3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - 4. Mount unit-mounted disconnect switches on exterior of unit.
- F. Variable-Frequency Motor Controller: Serving each fan individually in fan array.
 - 1. Manufactured Units: Pulse-width modulated; variable torque for inverter-duty motors.
 - 2. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
 - 3. Unit Operating Requirements:
 - a. Internal Adjustability:
 - 1) Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2) Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3) Acceleration: 0.1 to 999.9 seconds.
 - 4) Deceleration: 0.1 to 999.9 seconds.
 - 5) Current Limit: 30 to minimum of 150 percent of maximum rating.
 - b. Self-Protection and Reliability Features:
 - 1) Surge suppression.
 - 2) Loss of input signal protection.
 - 3) Under- and overvoltage trips.
 - 4) Variable-frequency motor controller and motor-overload/overtemperature protection.
 - 5) Critical frequency rejection.
 - 6) Loss-of-phase protection.
 - 7) Reverse-phase protection.
 - 8) Motor-temperature fault.
 - c. Bidirectional autospeed search.
 - d. Torque boost.
 - e. Motor temperature compensation at slow speeds.
 - 1) Panel-mounted operator station.
 - 2) Historical logging information and displays.
 - 3) Digital indicating devices.
 - f. Control Signal Interface: Electric.
 - g. Proportional Integral Directive (PID) control interface.
 - h. DDC system for HVAC Protocols for Network Communications: ASHRAE 135.

4. Line Conditioning:
 - a. Input line conditioning.
 - b. Output filtering.
 - c. EMI/RFI filtering.

2.6 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils are not to act as structural component of unit.

B. Supply-Air Refrigerant Coils:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: as required by the manufacturer.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: Corrosion-resistant coating.
7. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.

C. Hot-Gas Reheat Refrigerant Coils:

1. Tubes: Copper.
2. Fins:
 - a. Material: Aluminum.
 - b. Fin Spacing: as required by the manufacturer.
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: Corrosion-resistant coating.
7. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.
8. Coating: Corrosion-resistant coating.
9. Suction-discharge bypass valve.

D. Electric-Resistance Heating Coils: Comply with UL 1995.

1. Casing Assembly: Slip-in type with galvanized-steel frame.

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. Magnetic contactor.
 - b. Solid-state, stepless pulse controller.
 - c. Toggle switches, one per step.
 - d. SCR controller.
 - e. Time-delay relay.
 - f. Pilot lights, one per step.
 - g. Airflow proving switch.

E. Condenser Refrigerant coils:

1. Tube Material: Copper.
2. Fin Material: Aluminum.
3. Fin and Tube Joint: Mechanical bond.
4. Coating: None.

2.7 REFRIGERATION CIRCUIT COMPONENTS

- A. Compressors: Hermetic, variable-speed scroll compressors, mounted on integral vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- B. Refrigerant: R-410A.
- C. Refrigeration Specialties:
1. Expansion valve with replaceable thermostatic element.
 2. Refrigerant filter/dryer.
 3. Manual-reset high-pressure safety switch.
 4. Automatic-reset low-pressure safety switch.
 5. Minimum off-time relay.
 6. Automatic-reset compressor motor thermal overload.
 7. Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
 8. Brass service valves installed in discharge and liquid lines.
 9. Low-ambient kit high-pressure sensor.
 10. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
 11. Modulating hot-gas reheat solenoid valve with a replaceable magnetic coil.

2.8 AIR FILTRATION

- A. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
5. Prefilters:
 - a. Type: Panel,; Pleated. Approved equal to AFF Flanders.
 - b. Face Dimensions, each: as required by manufacturer.
 - c. Depth: 2 or 4 inches.
 - d. Number of Filters, Wide by High: as required by manufacturer.
 - e. Access Location: as required by manufacturer.
 - f. Maximum or Rated Face Velocity: 500 fpm.
 - g. Initial Resistance: 0.25 inches wg.
 - h. Recommended Final Resistance: 0.5 inches wg.
 - i. Minimum Efficiency Reporting Value:

1) MERV Rating: MERV 8, according to ASHRAE 52.2.

B. Cartridge Filters:

1. Description: Factory-fabricated, disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pleats are maintained in pleated form under rater-airflow conditions by corrugated aluminum separators.
4. Filter Media Frame: Galvanized steel.
5. Final Filters:
 - a. Type: Cartridge. Approved equal to AFF Flanders.
 - b. Face Dimensions, each: as required by manufacturer.
 - c. Depth: 12 inches.
 - d. Number of Filters, Wide by High: as required by manufacturer.
 - e. Access Location: as required by manufacturer.
 - f. Maximum or Rated Face Velocity: 500 fpm.
 - g. Initial Resistance: 0.3 inches wg.
 - h. Recommended Final Resistance: 1.0 inches wg.
 - i. Minimum Efficiency Reporting Value:

1) MERV Rating: MERV 13, according to ASHRAE 52.2.

C. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Cartridge filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

2.9 ROTARY HEAT EXCHANGER

A. Casing:

1. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.
 2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
 3. Casing seals on periphery of rotor and on duct divider and purge section.
 4. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings. Support horizontal rotors on tapered roller bearings.
- B. Rotor – Aluminum or Metallic: Aluminum or metallic segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
- C. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable-frequency controller. Provide permanently lubricated wheel bearings.
- D. Controls:
1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 2. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
 3. Control energy recovery to permit air economizer operation.
 - a. Bypass dampers to assist energy recovery control.
 4. Pilot-Light Indicator: Display rotor rotation and speed.
 5. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
 6. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
 7. Defrost cycle.

2.10 DAMPERS

- A. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in parallel-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg
- B. Electronic Damper Operators:
1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 2. Electronic damper position indicator shall have visual scale indicating percentage of travel and 2 to 10 V dc feedback signal.
 3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2 to 3 Inches wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3 to 4 Inches wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 120 V ac.
11. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2 to 10 V dc position feedback signal.
12. Temperature Rating: Minus 22 to plus 122 deg F.
13. Run Time: 12 seconds open, 5 seconds closed.

2.11 ELECTRICAL POWER CONNECTIONS

- A. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit except for service lights and convenience outlets, which are to be powered separately.
- B. Enclosure: NEMA 250, Type 4X, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface to be NEMA KS 1, heavy-duty, nonfused disconnect switch.
- F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.
 2. NEMA KS 1, heavy-duty, nonfusible switch.
 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.

- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
 - 1. Service Lights: 100W LED vaporproof luminaire with individual switched junction box located outside, adjacent to each access door and panel.
 - a. Locations: Each section accessed with door or panel.
 - 2. Convenience Outlets: One 20 A duplex GFCI receptacle per location with junction box located on outside casing wall.
 - a. Locations: Fan section.
- J. Control Relays: Auxiliary and adjustable time-delay relays.

2.12 CONTROLS

- A. Control Wiring: Factory wire connection for controls' power supply.
- B. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- C. Unit-Mounted Status Panel:
 - 1. Cooling/Off/Heating Controls: Control operational mode.
 - 2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
 - 3. Status Lights:
 - a. Filter dirty.
 - b. Fan operating.
 - c. Cooling operating.
 - d. Heating operating.
 - e. Smoke alarm.
 - f. General alarm.
 - 4. Digital Numeric Display:
 - a. See Numeric display output requirements on drawings.
- D. Refrigeration System Controls:
 - 1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.
 - 2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.
 - 3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 50 percent.
- E. Rotary Heat-Exchanger Control:

1. Sequence with refrigeration system controls and heating controls.
2. For operation of rotary heat exchanger itself, see "Rotary Heat Exchanger" Article and sequence of operation on drawings..

F. Electric-Resistance Heat Controls:

1. Factory-mounted sensor in unit discharge with sensor adjustment located in control panel to control electric coil to maintain temperature.
2. Capacity Controls: Modulating SCR.

G. Damper Controls: See sequence of operation on drawings.

H. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Links shall include the following:

1. Start/stop interface relay and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:
 - a. Room temperature.
 - b. Discharge-air temperature.
 - c. Refrigeration system operation.

I. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

2.13 ROOF CURBS

A. Roof curbs with vibration isolators and wind restraints are specified in Section 230548 "Vibration Controls for HVAC."

B. Materials: Galvanized steel with corrosion-resistant coating, watertight gaskets, and factory-installed wood nailer; complying with National Roofing Contractors Association manuals for the specific type of roofing applicable to the Project.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C1071, Type I or II.
 - b. Thickness: 2 inches.
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service air velocity.

C. Curb Dimensions: Height of 14 inches.

- D. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

2.14 INTAKE AND RELIEF OPENINGS

- A. Type: Manufacturer's standard hood or louver, including moisture eliminator, at all unit intake and relief openings.
- B. Materials: Match material and finish of casing exterior.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.15 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.
- E. Corrosion-Resistant Coating: Coat casing with a corrosion-resistant coating capable of withstanding a 3,000-hour salt-spray test in accordance with ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb.
 - c. ASTM D3359 for cross-hatch adhesion of 5B.
 - 2. Application: Immersion.
 - 3. Thickness: 1 mil.
 - 4. Gloss: Minimum gloss of 50 gloss units on a single angle 60-degree meter.

2.16 SOURCE QUALITY CONTROL

- A. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label unit fan sound ratings in accordance with AHRI 260 or AMCA 311.

- B. Fan Aerodynamic Performance Rating: Test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency.
 - 1. Fan Aerodynamic Performance Rating: Test and rate fan performance in accordance with AMCA 210.
- C. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.
- D. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
- E. Damper Leakage and Air Performance:
 - 1. Damper Rating: Test and rate dampers for leakage and air performance in accordance with AMCA 510.
- F. Refrigerant Coils: Factory tested to minimum 300 psig internal pressure and to minimum 300 psig internal pressure while under water, in accordance with AHRI 410 and ASHRAE 33.

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 roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Roof Curb: Install on roof structure, level and secure, in accordance with NRCA's "The NRCA Roofing Manual: Membrane Roof Systems". Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided. Coordinate with vibration isolation base specified in Section 230548 "Vibration Control for HVAC".
- B. 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.
- C. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- D. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

- E. Install duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.
- F. Install separate devices furnished by manufacturer and not factory installed.
- G. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to units, allow space for service and maintenance.
- C. Condensate Drain Connections:
 - 1. Comply with requirements in Section 221414 "Storm Drainage Piping"
- D. Duct Connections:
 - 1. Comply with requirements in Section 233113 "Metal Ducts."
 - 2. Drawings indicate the general arrangement of ducts.
 - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "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.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Division 26.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
3. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
4. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
5. Inspect casing insulation for integrity, moisture content, and adhesion.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean coils and inspect for construction debris.
10. Inspect and adjust vibration isolators and wind restraints.
11. Verify bearing lubrication.
12. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Start unit.
14. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
15. Operate unit for run-in period.
16. Calibrate controls.
17. Adjust and inspect high-temperature limits.
18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
19. Verify operational sequence of controls.
20. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Relief-air flow.
 - c. Outdoor-air flow.

- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate, and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.7 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

- C. Occupancy Adjustments: When requested within 12 months 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.

3.8 CLEANING

- A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Charge refrigerant coils with refrigerant and test for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 237433

SECTION 238129 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: VRF HVAC systems.
 - 1. Indoor, concealed, ceiling-mounted units for ducting.
 - 2. Indoor, exposed, wall-mounted units.
 - 3. Indoor, recessed, ceiling-mounted units.
 - 4. Outdoor, air-source heat-pump units.
 - 5. Outdoor, air-source heat recovery units.
 - 6. Heat recovery control units (HRCUs).
 - 7. System controls.
 - 8. System refrigerant and oil.
 - 9. System condensate drain piping.
 - 10. System refrigerant piping.
 - 11. Metal hangers and supports.
 - 12. Fastener systems.
 - 13. Pipe stands.
 - 14. Outdoor equipment stands.
 - 15. Piping and tubing insulation.
 - 16. System control cable.

1.2 DEFINITIONS

- A. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.
- B. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.
- C. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.
- D. 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.
- E. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- F. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

- G. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.
- H. VRF: Variable refrigerant flow.

1.3 ACTION SUBMITTALS

- A. Product Data: For VRF HVAC system components.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
 - 4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
 - 5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
 - 6. Include description of control software features.
 - 7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
 - 8. Include refrigerant type and data sheets showing compliance with requirements indicated.
 - 9. For system design software.
 - 10. Indicate location and type of service access.
- B. Shop Drawings: For VRF HVAC systems.
 - 1. Include plans, elevations, sections, and mounting 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. 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.
 - 4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
 - 5. Include diagrams for power, signal, and control wiring.
- C. Delegated Design Submittals:
 - 1. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
 - 2. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
 - 3. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
 - 5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
 - 6. Items penetrating finished ceiling including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Service access panels.
- B. Qualification Data:
 - 1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
 - a. Retain copies of Installer certificates on-site and make available on request.
 - 2. For VRF HVAC system manufacturer.
 - 3. For VRF HVAC system provider.
- C. Product Certificates: For VRF HVAC system components.
- D. Product Test Reports: Where tests are required, for each product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranties: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.

2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

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:
 - a. One set(s) for each unit with replaceable filters.
 - b. One set(s) for each unit type and unique size of washable filters.
2. Indoor Units: One for each unique size and type installed.
3. Controllers for Indoor Units: One for each unique controller type installed.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of 10 years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing, and quality control.
 - d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
 - e. Owner training.

- B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. In-place facility located within 50 miles of Project.
3. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope, and value.
 - a. Each person assigned to Project shall have demonstrated past experience.
5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.

7. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.
 8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.
- C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.
1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
 2. Installer certification shall be valid and current for duration of Project.
 3. Retain copies of Installer certificates on-site and make available on request.
 4. Each person assigned to Project shall have demonstrated past experience.
 - a. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
 - b. Demonstrated past experience on five projects of similar complexity, scope, and value.
- D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean and dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
 2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
- E. Replace installed products damaged during construction.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures.

- b. Faulty operation.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
- 2. Warranty Period:
 - a. For Compressor: 10 year(s) from date of Substantial Completion.
 - b. For Parts, Including Controls: 10 year(s) from date of Substantial Completion.
 - c. For Labor: 10 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VRF HVAC SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Mitsubishi Electric & Electronics USA, Inc. (Trane)
- B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:
 - 1. Indoor and outdoor units, including accessories.
 - 2. Controls and software.
 - 3. HRCUs.
 - 4. Refrigerant isolation valves.
 - 5. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

- A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
 - 1. Two-pipe system design.
 - 2. System(s) operation, heat pump and heat recovery as indicated on Drawings.
 - 3. Each system with one refrigerant circuit shared by all indoor units connected to system.
- 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. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.
- D. ASHRAE Compliance:
 - 1. ASHRAE 15: For safety code for mechanical refrigeration.
 - 2. ASHRAE 62.1: For indoor air quality.
 - 3. ASHRAE 135: For control network protocol with remote communication.
 - 4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

- E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional specialist, as defined in Section 014000 "Quality Requirements," to design complete and operational VRF HVAC system(s) complying with requirements indicated.
1. Provide system refrigerant calculations.
 - a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
 - b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.
 2. System Refrigerant Piping and Tubing:
 - a. Arrangement and routing of piping is shown on the drawings. Arrange piping to interconnect indoor units, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated. Conceal piping above ceilings and behind walls as indicated on the drawings.
 - b. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.
 3. System Controls:
 - a. Network arrangement.
 - b. Network interface with other building systems.
 - c. Product selection.
 - d. Sizing.
- B. Service Access:
1. Provide and document service access requirements.
 2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
 3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
 4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
 5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
 6. Comply with OSHA regulations.
- C. System Design and Installation Requirements:
1. Design and install systems indicated according to manufacturer's recommendations and written instructions.

2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.
 - D. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.
 - E. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:
 1. Range acceptable to manufacturer.
 - F. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.
 - G. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.
 - H. Outdoor Conditions:
 1. Suitable for outdoor ambient conditions encountered.
 - a. Design equipment and supports to withstand wind loads of governing code and ASCE/SEI 7.
 - b. Design equipment and supports to withstand snow and ice loads of governing code and ASCE/SEI 7.
 - c. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.
 2. Maximum System Operating Outdoor Temperature: See Drawings.
 3. Minimum System Operating Outdoor Temperature: See Drawings.
 - I. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.
 1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
 2. Outdoor: Within ordinance of governing authorities.
 - J. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.
 - K. Capacities and Characteristics: As indicated on Drawings.
- 2.4 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING
- A. Drawing Designation: FCU.
 - B. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
 - C. Cabinet:
 1. Material: Galvanized or painted steel.

2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
 3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
 4. Mounting: Manufacturer-designed provisions for field installation.
 5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- D. 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. Unit Internal Tubing: Copper tubing with brazed joints.
 6. Unit 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.
- E. 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: as required for connected piping specified elsewhere.
- F. 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-resistant 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.
- G. Filter Assembly:
1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
 2. Efficiency: ASHRAE 52.2, MERV 13.
 3. Media:
 - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

H. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

I. Unit Controls:

1. Enclosure: Metal, suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
 - a. Unit inlet air temperature.
 - b. Coil entering refrigerant temperature.
 - c. Coil leaving refrigerant temperature.
4. Field-Customizable I/O Capability:
 - a. Analog Inputs: Two for use in customizable control strategies.
 - b. Digital Inputs: Two for use in customizable control strategies.
 - c. Digital Outputs: Two for use in customizable control strategies.
5. Features and Functions:
 - a. Self-diagnostics.
 - b. Time delay.
 - c. Auto-restart.
 - d. External static pressure control.
 - e. Auto operation mode.
 - f. Manual operation mode.
 - g. Filter service notification.
 - h. Power consumption display.
 - i. Drain assembly high water level safety shutdown and notification.
 - j. Run test switch.
6. Communication: Network communication with other indoor and outdoor units.
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.

J. Unit Electrical:

1. Enclosure: Metal, suitable for indoor locations.
2. Field Connection: Single point connection to power unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch.
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.

2.5 INDOOR, EXPOSED, WALL-MOUNTED UNITS

- A. Drawing Designation: FCU.
- B. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
- C. 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.
- D. 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. Unit Internal Tubing: Copper tubing with brazed joints.
 - 6. Unit 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.
- E. Drain Assembly:
 - 1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
 - 2. Condensate Removal: Gravity.
 - a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
 - 3. Field Piping Connection: as required for connected piping specified elsewhere.
- F. 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.
- G. Filter Assembly:
1. Access: Front, to accommodate filter replacement without the need for tools.
 2. Efficiency: MERV 13
 3. Washable Media: Manufacturer's standard filter with antimicrobial treatment.
- H. Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top or front face of unit cabinet.
- I. Unit Accessories:
1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
 2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.
- 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 Coil leaving refrigerant temperature.
 4. Field-Customizable I/O Capability:
 - a. Analog Inputs: Two for use in customizable control strategies.
 - b. Digital Inputs: Two for use in customizable control strategies.
 - c. Digital Outputs: Two for use in customizable control strategies.
 5. Features and Functions: Self-diagnostics, time delay, auto-restart, external static pressure control, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, 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.

2.6 INDOOR, RECESSED, CEILING-MOUNTED UNITS

- A. Drawing Designation: FCU.
- B. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
- C. 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.
- D. 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.
- E. 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: as required for connected piping specified elsewhere.
- F. 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.

G. Filter Assembly:

1. Access: Bottom, to accommodate filter replacement without the need for tools.
2. Efficiency: ASHRAE 52.2, MERV 11.
3. Media:
 - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

H. 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.

I. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

J. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

K. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

L. 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: Two for use in customizable control strategies.
 - c. Digital Outputs: Two for use in customizable control strategies.
5. Features and Functions: Self-diagnostics, time delay, auto-restart, external static pressure control, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, 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.

M. 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.

2.7 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS

A. Drawing Designation: HPU.

B. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

C. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.
 - a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

D. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:
 - a. High refrigerant pressure.
 - b. Low oil level.
 - c. High oil temperature.
 - d. Thermal and overload.
 - e. Voltage fluctuations.
 - f. Phase failure and phase reversal.
 - g. Short cycling.
3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.

4. Vibration Control: Integral isolation to dampen vibration transmission.
 5. Oil management system to ensure safe and proper lubrication over entire operating range.
 6. Crankcase heaters with integral control to maintain safe operating temperature.
 7. Fusible plug.
- E. Condenser Coil Assembly:
1. Plate Fin Coils:
 - a. Casing: Aluminum, galvanized, or stainless steel.
 - b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
 - c. Tubes: Copper, of diameter and thickness required by performance.
 2. Aluminum Microchannel Coils:
 - a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
 - b. Single- or multiple-pass arrangement.
 - c. Construct fins, tubes, and header manifolds of aluminum alloy.
 3. Coating: Corrosion resistant.
 4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
- F. Condenser Fan and Motor Assembly:
1. Fan(s): Propeller type.
 - a. Direct-drive arrangement.
 - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
 - c. Statically and dynamically balanced.
 2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
 3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
 4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
 6. Vibration Control: Integral isolation to dampen vibration transmission.
- G. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
- H. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
 2. Factory-Installed Controller: Configurable digital control.
 3. Factory-Installed Sensors:
 - a. Refrigerant suction temperature.

- b. Refrigerant discharge temperature.
 - c. Outdoor air temperature.
 - d. Refrigerant high pressure.
 - e. Refrigerant low pressure.
 - f. Oil level.
 - g. .
 - 4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch equalize run time between multiple same components.
 - 5. Communication: Network communication with indoor units and other outdoor unit(s).
 - 6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 - 7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
- I. Unit Electrical:
- 1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor 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.
- J. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevent corrosion when exposed to salt spray test for 1000 hours according to ASTM B117.
- K. Unit Piping:
- 1. Unit Tubing: Copper tubing with brazed joints.
 - 2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
 - 3. Field Piping Connections: Manufacturer's standard.
 - 4. Factory Charge: Dehydrated air or nitrogen.
 - 5. Testing: Factory pressure tested and verified to be without leaks.

2.8 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

- A. Drawing Designation: HRU.
- B. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
- 1. Specially designed for use in systems with simultaneous heating and cooling.
 - 2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
 - 3. All units installed shall be from the same product development generation.

C. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.
 - a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

D. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:
 - a. High refrigerant pressure.
 - b. Low oil level.
 - c. High oil temperature.
 - d. Thermal and overload.
 - e. Voltage fluctuations.
 - f. Phase failure and phase reversal.
 - g. Short cycling.
3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

E. Condenser Coil Assembly:

1. Plate Fin Coils:
 - a. Casing: Aluminum, galvanized, or stainless steel.
 - b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
 - c. Tubes: Copper, of diameter and thickness required by performance.
2. Aluminum Microchannel Coils:
 - a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
 - b. Single- or multiple-pass arrangement.
 - c. Construct fins, tubes, and header manifolds of aluminum alloy.
3. Coating: Corrosion resistant.
4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

F. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.
 - a. Direct-drive arrangement.
 - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
 - c. Statically and dynamically balanced.
 2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
 3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
 4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
 5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
 6. Vibration Control: Integral isolation to dampen vibration transmission.
- G. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
- H. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
 2. Factory-Installed Controller: Configurable digital control.
 3. Factory-Installed Sensors:
 - a. Refrigerant suction temperature.
 - b. Refrigerant discharge temperature.
 - c. Outdoor air temperature.
 - d. Refrigerant high pressure.
 - e. Refrigerant low pressure.
 - Oil level..
 4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch equalize run time between multiple same components.
 5. Communication: Network communication with indoor units and other outdoor unit(s).
 6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
 7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
- I. Unit Electrical:
1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor 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.

J. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevent corrosion when exposed to salt spray test for 1000 hours according to ASTM B117.

K. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.9 HEAT RECOVERY CONTROL UNITS (HRCUs)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

B. Cabinet:

1. Galvanized-steel construction.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Refrigeration Assemblies and Specialties:

1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
2. Each refrigerant branch circuit shall have refrigerant control valve(s) to control refrigerant flow.
3. Spares: Each heat recovery control unit shall include at least two branch circuit port(s) for future use.
4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
5. Each branch circuit connection shall be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.
 - a. If not available as an integral part of the heat recovery control unit, isolation valves shall be field installed adjacent to the unit pipe connection.

E. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Features and Functions: Self-diagnostics, fuse protection.
4. Communication: Network communication with indoor units and outdoor unit(s).
5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

F. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, 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.

G. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.10 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a TIA-485A or manufacturer-selected control network.
2. Network Communication Protocol: Open control communication between interconnected units.
3. Operator Interface:
 - a. Operators shall interface with system and unit controls through the following:
 - 1) Operator interfaces integral to controllers.
 - 2) Owner-furnished PC connected to central controller(s).
 - 3) Web interface through web browser software.
 - 4) Integration with Building Automation System.
 - b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

- 1) On/off control.
- 2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
9. Supports Multiple Languages: English or Spanish.
10. Displays service notifications and error codes.
11. Monitors and displays up to 3000 item error history and 10000 item operation history for regular reporting and further archiving.
12. Monitors and displays cumulative operating time of indoor units.
13. Able to disable and enable operation of individual controllers for indoor units.
14. Information displayed on individual controllers shall also be available for display.
15. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
 - a. Include multiple interconnected controllers as required.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
 - a. Sets schedule for daily, weekly, and annual events.
 - b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.

6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel.

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. Multiple Language: English or Spanish.
4. Temperature Units: Fahrenheit.
5. On/Off: Turns indoor unit on or off.
6. Hold: Hold operation settings until hold is released.
7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
8. Temperature Display: 1-degree increments.
9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between 60-90F.
10. Relative Humidity Display: 1 percent increments.
11. Relative Humidity Set-Point: Adjustable in 1 percent increments between 30-60%.
12. Fan Speed Setting: Select between available options furnished with the unit.
13. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
14. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
15. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
16. Occupancy detection.
17. Service Notification Display: "Filter".
18. Service Run Tests: Limit use by service personnel to troubleshoot operation.
19. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
20. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
21. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
22. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

2.11 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.
3. R-410a.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.
- 2.12 SYSTEM CONDENSATE DRAIN PIPING
- A. Comply with requirements in Section 221414 "Storm Drainage Piping" for system piping requirements.
- 2.13 SYSTEM REFRIGERANT PIPING
- A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.
 - B. Refrigerant Tubing Kits:
 1. Furnished by VRF HVAC 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 insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
 5. Factory Charge: Dehydrated air or nitrogen.
 - C. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.
 - D. 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.
- 2.14 METAL HANGERS AND SUPPORTS
- A. Comply with requirement in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- 2.15 FASTENER SYSTEMS
- A. Comply with requirement in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- 2.16 PIPE STANDS
- A. Comply with requirement in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

2.17 OUTDOOR EQUIPMENT STANDS

- A. Comply with requirement in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

2.18 PIPING AND TUBING INSULATION

- A. Comply with requirements in Section 230719 "HVAC Piping Insulation" for system piping insulation requirements.
- B. Comply with requirements in Section 220719 "Plumbing Piping Insulation" for condensate drain piping insulation requirements:

2.19 SYSTEM CONTROL CABLE

- A. Cable Rating: Listed and labeled for application according to NFPA 70.
 - 1. 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.
 - a. Flame Travel Distance: 60 inches or less.
 - b. Peak Optical Smoke Density: 0.5 or less.
 - c. Average Optical Smoke Density: 0.15 or less.
 - 2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
 - 3. 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.
- B. Low-Voltage Control Cabling:
 - 1. Paired Cable: NFPA 70, Type CMG.
 - a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
 - b. PVC insulation.
 - c. Braided or foil shielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1685.
 - 2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
 - b. PVC insulation.
 - c. Braided or foil shielded.
 - d. PVC jacket.
 - e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

- f. Flame Resistance: Comply with NFPA 262.
- C. TIA-485A Network Cabling:
 - 1. Standard Cable: NFPA 70, Type CMG.
 - a. Paired, one pair, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.
 - e. Flame Resistance: Comply with UL 1685.
 - 2. Plenum-Rated Cable: NFPA 70, Type CMP.
 - a. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - b. Fluorinated ethylene propylene insulation.
 - c. Unshielded.
 - d. Fluorinated ethylene propylene jacket.
 - e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
 - f. Flame Resistance: NFPA 262.
 - 3. Lead Content: Less than 300 parts per million.
 - 4. Ethernet Network Cabling: TIA-568-C.2 Category 6 cable with RJ-45 connectors.
 - 5. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
 - 6. Conductors: 100-ohm, 23 AWG solid copper.
 - 7. Lead Content: Less than 300 parts per million.
 - 8. Shielding: Shielded twisted pairs (FTP).
 - 9. Cable Rating: By application.
 - 10. Jacket: White thermoplastic.
- D. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for cable raceways.

2.20 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.

- E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb.
 - c. ASTM B3359 for cross-hatch adhesion of 5B.
2. Application: Immersion.
3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.21 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect factory-assembled equipment.
- B. Equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports for historical record. Submit reports only if requested.

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 products before installation. Reject products that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.
- D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.
- E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.
- F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
- G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

- A. Clearance:
 - 1. Maintain manufacturer's recommended clearances for service and maintenance.
 - 2. Maintain clearances required by governing code.
- B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.
 - 1. Loose components shall be installed by manufacturer's service representative or system Installer under supervision of manufacturer's service representative.

3.3 INSTALLATION OF INDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.
- C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
- D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.
- E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
- F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
- G. For wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.
- H. Attachment: Install hardware for proper attachment to supported equipment.

3.4 INSTALLATION OF OUTDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Install outdoor units on support structures indicated on Drawings.
- C. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, stainless steel fasteners.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

- B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping and tubing to permit valve servicing.
- F. Install piping and tubing at indicated slopes.
- G. Install piping and tubing free of sags.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping and tubing to allow application of insulation.
- J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.
- K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."
- L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Escutcheons for HVAC Piping."

3.6 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.
 - 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 two 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 and shutoff valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 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 as specified if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

G. Unless otherwise required by VRF HVAC 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.

H. When brazing, remove or protect components that could be damaged by heat.

I. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

J. Comply with requirements as specified in Section 232300 "Refrigerant Piping."

3.8 INSTALLATION OF METAL HANGERS AND SUPPORTS

A. Comply with requirements specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment and Section 220529 "Hangers and Support for Plumbing Piping and Equipment."

3.9 INSTALLATION OF PIPING AND TUBING INSULATION

- A. Comply with requirements as specified in Section 230719 "HVAC Piping Insulation" and Section 220719 "Plumbing Piping Insulation".

3.10 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

- A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.
- B. Comply with requirements for metal ducts specified in Section 233113 "Metal Ducts."
- C. Comply with requirements for air duct accessories specified in Section 233300 "Air Duct Accessories."
- D. Comply with requirements for flexible ducts specified in Section 233346 "Flexible Ducts."
- E. Comply with requirements for air diffusers specified in Section 233713.13 "Air Diffusers."
- F. Comply with requirements for registers and grilles specified in Section 233713.23 "Registers and Grilles."

3.11 ELECTRICAL CONNECTIONS

- A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.
- B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.
 - 1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.
- C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.
- F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch high.
 - 2. Locate nameplate or label where easily visible.
- G. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or revised in this Section.

- H. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for box selection and installation requirements for boxes as supplemented or revised in this Section.
- I. Comply with requirements in Division 26. for wireways selection and installation requirements for wireways as supplemented or revised in this Section.
 - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
 - 2. Flexible metal conduit shall not be used.
- J. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- K. Install manufactured conduit sweeps and long-radius elbows if possible.
- L. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.12 SOFTWARE

- A. Cybersecurity:
 - 1. Software:
 - a. Coordinate security requirements with IT department.
 - b. Ensure that latest stable software release is installed and properly operating.
 - c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.
 - 2. Hardware:
 - a. Coordinate location and access requirements with IT department.
 - b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
 - c. Disable dual network connections.

3.13 INSTALLATION OF SYSTEM CONTROL CABLE

- A. Comply with NECA 1.
- B. Installation Method:
 - 1. Install cables in raceways except as follows:
 - a. Within equipment and associated control enclosures.
 - b. In accessible ceiling spaces where open cable installation method may be used.
 - c. In gypsum board partitions where cable may be enclosed within wall cavity.
 - 2. Conceal raceway and cables except in unfinished spaces.

C. 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; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.
5. Cables serving a common system may be grouped in a common raceway. Install control 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 inches and not more than 6 inches 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 or access panels.
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.
15. Do not bend cables in a radius less than 10 times the cable OD.
16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist balanced twisted-pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
2. Cable shall 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. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.14 FIRESTOPPING

A. Comply with requirements in Section 078413 "Through Penetration Firestop Systems."

- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.15 GROUNDING INSTALLATION

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.16 IDENTIFICATION

- A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."
 - B. Identify system condensate drain piping and valves. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
 - C. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- 1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.17 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
 - 1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
 - 2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.
 - a. First Visit: Kick-off meeting.
 - b. Second Visit: At approximately 25 percent completion of system(s).
 - c. Third Visit: At approximately 50 percent completion of system(s).
 - d. Fourth Visit: At approximately 75 percent completion of system(s).
 - e. Fifth Visit: Final inspection before system startup.
 - 3. Kick-off Meeting:
 - a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.

- b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
 - c. Meeting shall cover the following as a minimum requirement:
 - 1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
 - 2) Manufacturer's installation requirements specific to systems being installed.
 - 3) Review of all relevant VRF HVAC system submittals, including delegated design submittals.
 - 4) Required field activities related installation of VRF HVAC system.
 - 5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.
4. Site Visits: Activities for each site visit shall include the following:
- a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
 - b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
 - c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
 - d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
 - e. Issue a report for each visit, documenting the visit.
 - 1) Report to include name and contact information of individual making the visit.
 - 2) Date(s) and time frames while on-site.
 - 3) Names and contact information of people meeting with while on-site.
 - 4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.
5. Final Inspection before Startup:
- a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
 - b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
 - c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
 - d. Inspection reports for indoor units shall include, but not be limited to, the following:
 - 1) Unit designation on Drawings.
 - 2) Manufacturer model number.
 - 3) Serial number.
 - 4) Network address, if applicable.
 - 5) Each equipment setting.
 - 6) Mounting, supports, and restraints properly installed.

- 7) Proper service clearance provided.
- 8) Wiring and power connections correct.
- 9) Line-voltage reading(s) within acceptable range.
- 10) Wiring and controls connections correct.
- 11) Low-voltage reading(s) within an acceptable range.
- 12) Controller type and model controlling unit.
- 13) Controller location.
- 14) Temperature settings and readings within an acceptable range.
- 15) Humidity settings and readings within an acceptable range.
- 16) Condensate removal acceptable.
- 17) Fan settings and readings within an acceptable range.
- 18) Unit airflow direction within an acceptable range.
- 19) If applicable, fan external static pressure setting.
- 20) Filter type and condition acceptable.
- 21) Noise level within an acceptable range.
- 22) Refrigerant piping properly connected and insulated.
- 23) Condensate drain piping properly connected and insulated.
- 24) If applicable, ductwork properly connected.
- 25) If applicable, external interlocks properly connected.
- 26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:

- 1) Unit designation on Drawings.
- 2) Manufacturer model number.
- 3) Serial number.
- 4) Network address, if applicable.
- 5) Each equipment setting.
- 6) Mounting, supports, and restraints properly installed.
- 7) Proper service clearance provided.
- 8) Wiring and power connections correct.
- 9) Line-voltage reading(s) within acceptable range.
- 10) Wiring and controls connections correct.
- 11) Low-voltage reading(s) within an acceptable range.
- 12) Condensate removal acceptable.
- 13) Noise level within an acceptable range.
- 14) Refrigerant piping properly connected and insulated.
- 15) Condensate drain piping properly connected and insulated.
- 16) Remarks.

- f. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
- g. Installer shall correct observed deficiencies found by the inspection.
- h. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
- i. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
- j. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Refrigerant Tubing Positive Pressure Testing:
1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
 2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.2 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
 3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
 4. Prepare test report to record the following information for each test:
 - a. Name of person starting test, company name, phone number, and e-mail address.
 - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
 - c. Detailed description of extent of tubing tested.
 - d. Date and time at start of test.
 - e. Test pressure at start of test.
 - f. Outdoor temperature at start of test.
 - g. Name of person ending test, company name, phone number, and e-mail address.
 - h. Date and time at end of test.
 - i. Test pressure at end of test.
 - j. Outdoor temperature at end of test.
 - k. Remarks:
 5. Submit test reports for Project record.
- D. Refrigerant Tubing Evacuation Testing:
1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
 2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
 3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.
 4. Prepare test report to record the following information for each test:
 - a. Name of person starting test, company name, phone number, and e-mail address.
 - b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
 - c. Detailed description of extent of tubing tested.
 - d. Date and time at start of test.
 - e. Test pressure at start of test.
 - f. Outdoor temperature at start of test.
 - g. Name of person ending test, company name, phone number, and e-mail address.
 - h. Date and time at end of test.

- i. Test pressure at end of test.
 - j. Outdoor temperature at end of test.
 - k. Remarks:
- 5. Submit test reports for Project record.
- 6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.
- E. System Refrigerant Charge:
 - 1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
 - 2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
 - 3. System refrigerant charging shall be witnessed by system manufacturer's representative.
 - 4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.
- F. Products will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.18 STARTUP SERVICE

- A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.
 - 1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
 - 2. Complete startup service of each separate system.
 - 3. Complete system startup service according to manufacturer's written instructions.
- B. Startup checks shall include, but not be limited to, the following:
 - 1. Check control communications of equipment and each operating component in system(s).
 - 2. Check each indoor unit's response to demand for cooling and heating.
 - 3. Check each indoor unit's response to changes in airflow settings.
 - 4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
 - 5. Check sound levels of each indoor and outdoor unit.
- C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
 - 1. Installer shall correct deficiencies found during startup service for reverification.
- D. System Operation Report:
 - 1. After completion of startup service, manufacturer shall issue a report for each separate system.

2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.

a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Commissioning Agent to witness startup service procedures.
2. Provide written notice not less than 20 business days before start of startup service.

3.19 ADJUSTING

- A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
- C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.
- D. 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.

3.20 PROTECTION

- A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
- B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
- C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.
- D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.21 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include two service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.22 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. 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 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 the system and to upgrade computer equipment if necessary.

3.23 DEMONSTRATION

- A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.
- B. Instructor:
 - 1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
 - 2. Instructor's credentials shall be submitted for review by Commissioning Agent before scheduling training.
 - 3. Instructor(s) primary job responsibility shall be Owner training.
 - 4. Instructor(s) shall have not less than three years of training experience with VRF HVAC system manufacturer and past training experience on at least three projects of comparable size and complexity.
- C. Schedule and Duration:
 - 1. Schedule training with Owner's maintenance personnel at least 20 business days before first training session.
 - 2. Training shall occur before Owner occupancy.
 - 3. Training shall be held at mutually agreed date and time during normal business hours.
 - 4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for one-hour lunch period and 15-minute break after every two hours of training.
 - 5. Perform not less than eight total hours of training.
- D. Location: Owner's Representative shall provide a suitable on-site location to host classroom training.
- E. Training Attendees: Assume three people.
- F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.
- G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.
- H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 2. Video record each classroom training session and submit an electronic copy to Owner's Representative before requesting Owner's Representative's acceptance of training.
- I. Acceptance: Obtain Commissioning Agent or Owner's Representative's written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 238129

SECTION 238233 - CONVECTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes electric convectors.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and 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 details and dimensions of custom-fabricated enclosures.
 - 4. Indicate location and size of each field connection.
 - 5. Include enclosure joints, corner pieces, access doors, and other accessories.
 - 6. Indicate location and arrangement of integral controls
 - 7. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor 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:
 - 1. Structural members, including wall construction, to which convectors will be attached.
 - 2. Method of attaching convectors to building structure.
 - 3. Penetrations of fire-rated wall and floor assemblies.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 ELECTRIC CONVECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Berko; Marley Engineered Products.
 - 2. Chromalox, Inc.

3. INDEECO.
 4. Markel Products Company; a subsidiary of TPI Corporation.
 5. Marley Engineered Products.
 6. Ouellet Canada Inc.
 7. QMark; Marley Engineered Products.
 8. STELPRO DESIGN INC.
- B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.
1. 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. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of element. Element supports shall eliminate thermal expansion noise.
1. Electrical Characteristics as indicated in drawing schedules.
- D. Front and Top Panel: Minimum 0.0528-inch- thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
- E. Sill height - Wall-Mounted Back and End Panels: Minimum 0.0428-inch- thick steel.
- F. Floor-Mounted Pedestals (for CONV-2): Conceal conduit for power and control wiring at maximum 36-inch spacing. Pedestal-mounted back panel shall be solid panel matching front panel.
- G. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
- H. Insulation: 1/2-inch- thick, fibrous glass on inside of the back of the enclosure.
- I. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
- J. Damper: Knob-operated internal damper.
- K. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.
- L. Enclosure Style: Flat top.
1. Top Outlet Grille: Punched louver; painted to match enclosure.
 2. Enclosure Dimensions: As indicated in drawing schedules.
- M. Unit Controls: Integral line-voltage thermostat with minimum range of 60 to 90 deg F.
- N. Accessories: Integral disconnect switch, recessing flanges finished to match enclosure or overlapping front cover for fully recessed units, and rubber gaskets to seal cabinet at wall.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive convectors for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before installation of convector.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install convectors level and plumb.

3.3 CONNECTIONS

- A. Ground electric convectors according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start convectors to confirm proper operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Convectors will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 238233

SECTION 238239.16 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes propeller unit heaters with electric-resistance heating coils.

1.2 DEFINITIONS

- A. PTFE: Polytetrafluoroethylene plastic.
- B. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and 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 location and size of each field connection.
 - 4. Include details of anchorages and attachments to structure and to supported equipment.
 - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 6. Indicate location and arrangement of integral controls.
 - 7. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which propeller unit heaters will be attached.
 - 3. Method of attaching hangers to building structure.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airtherm; a Mestek company.
 - 2. CCI Thermal Technologies, Inc.
 - 3. Engineered Air.
 - 4. Trane.

2.2 DESCRIPTION

- A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- 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 UL 2021.

2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

- A. General Coil Requirements: Test and rate propeller unit-heater coils according to ASHRAE 33.
- B. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
 - 1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
 - 2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated. Comply with requirements in Section 230500 "Common Work Results for HVAC."

2.7 CONTROLS

- A. Control Devices:
 - 1. Unit-mounted, fan-speed switch.
 - 2. Unit-mounted thermostat.

2.8 CAPACITIES AND CHARACTERISTICS

- A. As scheduled on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.

- C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration Controls for HVAC."

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of equipment.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238239.16

SECTION 260050 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Common electrical installation requirements.

1.2 DESCRIPTION OF WORK

A. Requirements of this Section are applicable to work in Divisions 26 and 28.

B. Contract Documents

1. Contract drawings for electrical work are diagrammatic, intended to convey scope and general arrangement.
2. Refer questions involving document interpretation or discrepancies to Engineer for review and direction.
3. Correct faulty work due to resolving discrepancies without proper approval.
4. Specifications establish quality of materials, equipment, workmanship and methods of construction.
5. Follow drawings and specifications in laying out work. Consult other applicable contract drawings and specifications, become familiar with conditions affecting work.

C. Scope

1. Contractor must furnish and install the electrical work complete and ready for satisfactory service.

D. Definitions: The following are definitions of terms and expressions used in Divisions 26 and 28.

1. "Accessible" – Capable of being removed or exposed without damaging the building or structure or finish or not permanently closed in by other equipment or by the structure or finish of the building.
2. "Approve" - To permit use of material, equipment or methods conditional upon compliance with contract document requirements.
3. "Concealed" - Hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
4. "Directed" - directed by Engineer.
5. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
6. "Exposed" - not concealed.
7. "Furnish" - Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar operations.
8. "Indicated" - indicated in Contract Documents.
9. "Install" - Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimensions, finishing, curing, protecting, cleaning and similar operations.
10. "Provide" - furnish and install, complete and ready for the intended use.

11. "Removable" - detachable from the structure or system without physical alteration of materials or equipment and without disturbance to other construction.
12. "Review" - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.3 QUALITY ASSURANCE

- A. Regulations: Comply with regulations of IBC, NFPA, state, county, and municipal building ordinances, and other applicable codes and regulations.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by the local authority as equivalent in safety to UL labeled equipment.
- C. Material and Equipment Requirements
 1. All materials and equipment shall be new and free from defects.
 2. Use products of one manufacturer where two or more items of same kind of equipment are required.
 3. For certain items of equipment, the specification and the project design are based upon the specified manufacturer's product. Other manufacturers' names are listed. Contractor may purchase, conditional upon meeting project requirements, equipment from the listed manufacturers.
 4. Only the manufacturer's equipment upon which the specification and the project design has been based, has been checked for this project. Check allocated space and structure for suitability of equipment of other listed manufacturers, including parts replacement and servicing.
- D. Workmanship
 1. Remove and replace, at no extra cost, work not in conformance with contract requirements.
 2. Coordinate with Other Trades
 - a. Coordinate work and cooperate with other trades to facilitate execution of work.
 - b. Give full cooperation and coordination with other trades and furnish information necessary to permit the work of all trades to be installed satisfactorily with the least possible interference or delay.
 - c. Furnish to other trades, as required, necessary templates, patterns, setting plans and shop details for the proper installation of the work and for the purpose of coordinating adjacent work.
 3. Accessible Equipment and Systems:
 - a. Consider all materials and equipment installations and coordinate with the work of other trades to ensure equipment or systems are accessible for operations, maintenance, repairs, and replacement.
 - b. Install materials and equipment, including but not limited to, supports and electrical conduit, to permit complete unobstructed access to panelboards, transformers, and other items requiring access for inspection, maintenance, and operations.
 - c. Engineer will disapprove the installation of new equipment or materials which renders new or existing equipment inaccessible, and Contractor shall correct the Work.

1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment as follows:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Penetration Firestopping."

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. Refer to Division 01 for complete requirements.
- B. Submit all products for a single specification section as a complete submittal. All products specified within a division shall be included, otherwise submittal will be returned as incomplete.
- C. Clearly mark submittals to indicate actual intended products to be utilized. Marks may include highlighting, circling, boxing, checking, etc. Do not provide submittal data which lists multiple product's options and features without clearly indicating which data applies to the products intended to be used on project.
- D. Coordinate drawings and data before submitting and certify that provisions of the contract documents have been met.
- E. Call attention, in writing, to deviations from contract requirements.
- F. Do not fabricate, deliver to site, or install items requiring shop drawing review, until the review has been completed by the Engineer and the shop drawing has been marked to indicate "No Exception Taken" or "Make Corrections Noted."
- G. Use only final or corrected drawings and data for construction. This includes all Addendums, Architectural Supplemental Information (ASIs), and Change Bulletins.
- H. The Engineer's review of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounted items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.
- F. Conditions of Occupancy
 - 1. This building will be occupied during the life of this contract. Execute work in a manner to impose minimal interference with the normal functioning of the building and its occupants. When interference is unavoidable, schedule work 14 days in advance with the Owner.
 - 2. Make temporary connections where necessary to maintain uninterrupted electrical service.
 - 3. Provide adequate protection for the building, its contents, and occupants.
 - 4. Perform work as quietly as possible to avoid unnecessary disturbance. Unusual precaution may be necessary in the conduct or work in some areas to achieve satisfactory compliance.
 - 5. Coordinate with Owner to Perform work producing high noise levels, dust, or hazards to occupants in occupied during non-business hours of the facility.
 - 6. Comply with regulations of Owner pertaining to circulation, sanitation, and behavior of Contractor's personnel.

3.2 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Penetration Firestopping."

END OF SECTION 260050

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Copper building wire.
 2. Metal-clad cable, Type MC.
 3. Connectors and splices.

1.2 ACTION SUBMITTALS

- A. Product Data:
1. Copper building wire.
 2. Metal-clad cable, Type MC.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cerro Wire LLC.
 2. Encore Wire Corporation.
 3. 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 THHN and Type THWN-2. Comply with UL 83.

2.2 METAL-CLAD CABLE, TYPE MC

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems; Atkore International.
 - 2. Alpha Wire; brand of Belden, Inc.
 - 3. Cerro Wire LLC.
 - 4. Encore Wire Corporation.
 - 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.
- 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.
- H. Armor: Steel, interlocked.

2.3 CONNECTORS AND SPLICES

- A. 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.
- B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: Two hole with long barrels.
 - 3. Termination: Compression.

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.

B. Branch Circuits:

1. Copper:
 - a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders: Type THHN/THWN-2, single conductors in raceway.

B. Branch Circuits Concealed in Ceilings, Walls, and Partitions:

1. Metal-clad cable, Type MC cable is permitted in accessible ceilings between luminaires and lighting control devices. Circuiting must convert to THHN/THWN-2, single conductors in raceway once distance exceeds 12-feet. Circuit homeruns to panelboards must be type THHN/THWN-2, single conductors in raceway. MC cable is not permitted for receptacle or other non-lighting circuits.
2. Type THHN/THWN-2, single conductors in raceway for all other applications.

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 260533.13 "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 260529 "Hangers and Supports for Electrical Systems."

3.4 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 12 inch of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "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.

3.6 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 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 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 078413 "Penetration Firestopping."

END OF SECTION 260519

SECTION 260526 - 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 connectors.

1.2 ACTION SUBMITTALS

- A. None required.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment Grounding Conductor:
 - 1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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.

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.

2.4 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.

PART 3 - EXECUTION

3.1 SELECTION OF GROUNDING AND BONDING PRODUCTS

- A. Grounding and Bonding Conductors:
 - 1. Provide solid conductor for 10 AWG and smaller, and stranded conductors for 8 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.

B. Grounding and Bonding Connectors:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Connections to Structural Steel: Welded connectors.

3.2 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. 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 bonding jumper to bond across flexible duct connections to achieve continuity.

3. Equipment Grounding and Bonding:

- a. Install insulated equipment grounding conductors with feeders and branch circuits.
- b. 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.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support, anchorage, and attachment components.

1.2 ACTION SUBMITTALS

- A. None required.**

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design:** Engage a qualified structural professional engineer to design hanger and support system.

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. ABB, Electrification Business.
- b. Allied Tube & Conduit; Atkore International.
- c. Atkore Unistrut.
- d. CADDY; brand of nVent Electrical plc.
- e. Cooper B-line; brand of Eaton, Electrical Sector.
- f. Flex-Strut Inc.
- g. G-Strut.
- h. Gripple Inc.
- i. Haydon Corporation.
- j. MIRO Industries Inc.
- k. Metal Ties Innovation.
- l. Rocket Rack; Robroy Industries.
- m. Wesanco/ZSi-Foster; an Ideal Tridon Group Company.

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. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. 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.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 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: Stainless steel springhead type.
 7. Hanger Rods: Threaded steel.

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.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."
- D. Comply with requirements for boxes specified in Section 260533.16 "Boxes and Covers for Electrical Systems."
- E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERM as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch in diameter.

- F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

- G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits 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 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: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69, or Spring-tension clamps.
 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 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

- B. Use 3000 psi, 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base as follows:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 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.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT-S duct raceways and elbows.
2. Type ERMC-A duct raceways, elbows, couplings, and nipples.
3. Type ERMC-S duct raceways, elbows, couplings, and nipples.
4. Type FMC-S duct raceways.
5. Type LFMC-S duct raceways.
6. Fittings for conduit, tubing, and cable.
7. Electrically conductive corrosion-resistant compounds for threaded conduit.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Type EMT-S duct raceways and elbows.
2. Type ERMC-A duct raceways, elbows, couplings, and nipples.
3. Type ERMC-S duct raceways, elbows, couplings, and nipples.
4. Type FMC-S duct raceways.
5. Type LFMC-S duct raceways.
6. Fittings for conduit, tubing, and cable.
7. Electrically conductive corrosion-resistant compounds for threaded conduit.

PART 2 - PRODUCTS

2.1 TYPE EMT-S DUCT RACEWAYS AND ELBOWS

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 FJMX; including UL 797.

B. UL FJMX - 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. Calconduit; Atkore International.
 - c. Emerson Electric Co., Automation Solutions.
 - d. Picoma; Zekelman Industries.

- e. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
 - f. Topaz Lighting & Electric.
 - g. Western Tube; Zekelman Industries.
 - h. 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: Metric designator 21 (trade size 3/4).
 - d. Colors: Red for Fire Alarm circuits.

2.2 TYPE ERMCA DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

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 DYWV; including UL 6A.

B. UL DYWV - Aluminum Electrical Rigid Metal Conduit (ERMC-A), 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. ABB, Electrification Business.
 - b. Allied Tube & Conduit; Atkore International.
 - c. American Conduit; Norsk Hydro ASA, Hydro Extrusion USA LLC.
 - d. Appleton; Emerson Electric Co., Automation Solutions.
 - e. Calconduit; Atkore International.
 - f. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - g. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - h. Patriot Aluminum Products, LLC.
 - i. Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway.
 - j. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
 - k. Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V.
- 2. Material: Aluminum.
- 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.3 TYPE ERMCS DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

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 DYIX; including UL 6.
- B. UL DYIX - 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. Calconduit; Atkore International.
 - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - d. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - e. Patriot Aluminum Products, LLC.
 - f. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
 - g. Rymco USA brand; manufactured and listed by subsidiary Conduit S.A. de C.V.
 - h. Topaz Lighting & Electric.
 - i. Western Tube; Zekelman Industries.
 - j. Wheatland Tube; Zekelman Industries.
 2. Exterior Coating: Zinc.
 3. Options:
 - a. Interior Coating: Zinc with organic top coating.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.4 TYPE FMC-S DUCT RACEWAYS

- 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 DXUZ; including UL 1.
- B. UL DXUZ - 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. Anaconda Sealtite; Anamet Electrical, Inc.
 - c. Electri-Flex Company.
 - d. International Metal Hose Co.
 - e. Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway.
 - f. Topaz Lighting & Electric.
 2. Material: Steel.

3. Options:

- a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.5 TYPE LFMC-S DUCT RACEWAYS

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 DXHR; including UL 360.

B. UL DXHR - 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. Anaconda Sealite; Anamet Electrical, Inc.
 - c. Electri-Flex Company.
 - d. International Metal Hose Co.
- 2. Material: Steel.
- 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.6 FITTINGS FOR CONDUIT, TUBING, AND CABLE

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.

B. UL DWTT - Fittings for Type ERM C Duct 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. Konkore Fittings; Atkore International.
 - e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
 - f. Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway.
 - g. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - h. Southwire Company, LLC.
 - i. Topaz Lighting & Electric.

2. Listing Criteria: UL CCN DWTT; including UL 514B.
 3. Options:
 - a. Material: Steel or Die cast.
 - b. Coupling Method: Threaded coupling.
- C. UL FKA V - Fittings for Type EMT Duct 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. Calconduit; Atkore International.
 - e. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - 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. Southwire Company, LLC.
 - i. Topaz Lighting & Electric.
 2. Listing Criteria: UL CCN FKA V; including UL 514B.
 3. Options:
 - a. Material: Steel or Die cast.
 - b. Coupling Method: Compression coupling.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.
- D. UL ILNR - Fittings for Type FMC-S Duct 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. Listing Criteria: UL CCN ILNR; including UL 514B.
- E. UL DXAS - Fittings for Type LFMC-S Duct 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. Listing Criteria: UL CCN DXAS; including UL 514B.

2.7 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

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 FOIZ; including UL Subject 2419.

B. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

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.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

- #### A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.

B. Outdoors:

1. Exposed and Subject to Contact with Earth and Concrete: ERM-C-S
2. Exposed and Not Subject to Contact with Earth and Concrete, such as on Rooftop of building: EMRC-A
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC-S.

C. Indoors:

1. Exposed: EMT.
2. Concealed in Ceilings and Interior Walls and Partitions: EMT-S.
3. Damp or Wet Locations: ERM-C-S.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC-S.

D. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

1. ERM-C-S: Provide threaded-type fittings unless otherwise indicated.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

- 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. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
 - 2. Type ERM-C-A: Article 344 of NFPA 70 and NECA NEIS 102.
 - 3. Type ERM-C-S: Article 344 of NFPA 70 and NECA NEIS 101.
 - 4. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
 - 5. Type LFM-C: Article 350 of NFPA 70 and NECA NEIS 101.
 - 6. Expansion Fittings: NEMA FB 2.40.
 - 7. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. General Requirements for Installation of Duct Raceways:
 - a. Complete duct raceway installation before starting conductor installation.
 - b. Make bends in duct 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.
 - c. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
 - d. Support conduit within 12 inch of enclosures to which attached.
 - e. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
 - f. Install devices to seal duct 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 duct raceways at the following points:
 - 1) Conduit extending from interior to exterior of building.
 - 2) Where otherwise required by NFPA 70.
 - g. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
 - h. Keep duct raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.
 - i. 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.
 - j. Install pull wires in empty duct 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 duct raceways designated as spare above grade alongside duct raceways in use.
 - k. Install duct 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.
 - 1) Termination fittings with shoulders do not require two locknuts.

- I. 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..
2. Type ERMCA: Do not install aluminum duct raceways or fittings in contact with concrete or earth.
3. Types ERMCA and ERMC-S:
 - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
4. Types FMC and LFMC:
 - a. Provide a maximum of 72 inch of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
5. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:
 - a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG.
6. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
 - a. EMT: Provide compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
 - b. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
7. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

3.3 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.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

PART 2 - PRODUCTS

2.1 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

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 QCIT; including UL 514A.

B. UL QCIT - Metallic Outlet Boxes and Covers:

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. Options:
 - a. Material: Sheet steel (indoor) or cast metal (outdoor).
 - b. Sheet Metal Depth: Minimum 2.5 inch.
 - c. Cast-Metal Depth: Minimum 2.4 inch.

C. UL QCIT - 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.

D. UL QCIT - Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.
2. Options:
 - a. Material: Sheet steel(indoor) or Cast metal(outdoor).
 - b. Sheet Metal Depth: minimum 2.5 inch.
 - c. Cast-Metal Depth: minimum 2.4 inch.

2.2 JUNCTION BOXES AND PULL BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN BGUZ; including UL 50 and UL 50E.

B. UL BGUZ - 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. Options:
 - a. Degree of Protection: Type 1.

C. UL BGUZ - 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. Options:
 - a. Degree of Protection: Type 1.

D. UL BGUZ - Outdoor 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. Options:
 - a. Degree of Protection: Type 3R.

2.3 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. Listing Criteria: UL CCN QCIT or UL CCN QCMZ; including UL 514D.

3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. UL QCIT or QCMZ - 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. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - c. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - d. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - e. Leviton Manufacturing Co., Inc.
 - f. Pass & Seymour; Legrand North America, LLC.
2. Options:
 - a. Wallplate Material: 0.032 inch thick, Type 302/304 non-magnetic stainless steel with brushed finish.

2.4 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. Listing Criteria:
 - a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
 - b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
3. Mounts to box using fasteners different from wiring device.

B. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:

1. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.
2. Options:
 - a. Provides gray, weatherproof, "while-in-use" cover.
 - b. Hood Material: Cast Aluminum.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published 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.
 2. Indoors:
 - a. Type 1 unless otherwise indicated.
- C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:
1. Provide cast-metal boxes. Boxes with knockouts or unprotected openings are prohibited.
 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.
- 3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS
- 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. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
 2. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
 2. 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.
 3. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
 4. Locate boxes so that cover or plate will not span different building finishes.
 5. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
 6. 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.
 7. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
 8. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
 9. 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.
 10. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - b. Provide gaskets for wallplates and covers.
 11. Identification: Provide labels for boxes and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.

3.3 CLEANING

- A. Remove construction dust and debris from boxes before installing wallplates, covers, and hoods.

3.4 PROTECTION

- A. After installation, protect boxes 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 260533.16

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Sleeve-seal fittings.
3. Grout.

B. Related Requirements:

1. Section 078413 "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. None required.**

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. 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 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.

2.3 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.

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 079200 "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.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

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.

3.2 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 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Tapes and stencils.
3. Signs.
4. Cable ties.

1.2 ACTION SUBMITTALS

A. None required.

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.

C. UL PGDQ2 - Self-Adhesive Wraparound Labels: Preprinted, 3 mil thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.

1. 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.
2. Marker for Labels:
 - a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. UL PGDQ2 - Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. 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 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.
- 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.
- C. Floor Marking Tape: 2 inch wide, 5 mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.3 SIGNS

- A. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. 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. Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 CABLE TIES

- 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 ZODZ; including UL 1565 or UL 62275.
- B. 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.
- C. 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.

- D. 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. Pipe and Conduit Labeling: Comply with ASME A13.1.
- C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
 - 1. Color must be factory applied.
 - 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 or gray.
 - 5. Color for Equipment Ground: Green.
- D. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

- 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. 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.
- G. Workspace Indication: Apply floor marking tape 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.
- H. Equipment Identification Labels:
 - 1. Black letters on white field.
 - 2. Indoor Equipment: Self-adhesive Laminated acrylic or melamine plastic sign.
 - 3. Outdoor Equipment: Laminated acrylic or melamine sign.
 - 4. Equipment to Be Labeled:
 - a. 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.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
 - e. Enclosed switches.
 - f. Enclosed circuit breakers.
 - g. Enclosed controllers.
 - h. Variable-speed controllers.
- I. 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 260573 "Power Study" requirements for arc-flash hazard warning labels.
2. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

3.4 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. 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.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Verify identity of item before installing identification products.
- E. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- F. Apply identification devices to surfaces that require finish after completing finish work.
- G. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- H. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- I. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- J. 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 260553

SECTION 260573 - POWER STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, fault-current study to determine minimum interrupting capacity of circuit protective devices.
2. 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.
3. Computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
 - a. Study results must be used to determine coordination of series-rated devices.

1.2 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.
- B. 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.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- D. p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.
- E. SCCR: Short-circuit current rating.
- F. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- G. 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 Report:

1. Submit the following concurrently with system protective devices submittals. Submittals must be in digital form.
 - a. Short-circuit study input data, including completed computer program input data sheets.
 - b. Arc-flash study input data, including completed computer program input data sheets.
 - c. Coordination-study input data, including completed computer program input data sheets.
 - d. 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.
 - e. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.
- C. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.5 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.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. CYME International T&D Inc.; subsidiary of Eaton Corporation plc.
 2. EDSA Micro Corporation.
 3. ESA Inc.
 4. ETAP; brand of Operation Technology, Inc.; subsidiary of Schneider Electric.
 5. EasyPower; brand of Bentley Systems, Inc.
 6. Power Analytics, Corporation.
 7. SKM Systems Analysis, Inc.

- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of power systems analysis software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output.
- E. Computer program must be designed to perform short-circuit studies or have function, component, or add-on module designed to perform short-circuit studies.
- F. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- 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 of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kVA and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6. Derating factors and environmental conditions.
 - 7. Any revisions to electrical equipment required by study.
- D. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
 - 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

2.3 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. Study Input Data: As described in "Power System Data" Article.
- E. 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.
- F. 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.
- G. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

2.4 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "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.

2.5 COORDINATION STUDY REPORT CONTENTS

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 of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Revisions to electrical equipment required by study.
7. Study Input Data: As described in "Power System Data" Article.

a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

- 1) Device tag.
- 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
- 3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

- 1) Adjustable pickups and time delays (long time, short time, and ground).
- 2) Adjustable time-current characteristic.
- 3) Adjustable instantaneous pickup.
- 4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices.

Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying portion of system covered.
2. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
3. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. Largest feeder circuit breaker in each motor-control center and panelboard.
5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
- B. 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 POWER SYSTEM DATA

- A. Obtain data necessary for conduct of study.
 1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.
- B. Gather and tabulate required input data to support short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
 1. Product Data for Project's overcurrent protective devices 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 at service.
 3. Power sources and ties.
 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 9. Motor horsepower and NEMA MG 1 code letter designation.
 10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
 11. Derating factors.

3.3 SHORT-CIRCUIT STUDY

- A. Perform study following general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is entire building's electrical distribution system from the BGE service down to every electrical bus/equipment indicated on the project one-line diagram including every piece of electrical distribution equipment including:
 1. Switchboards.
 2. Panelboards.
 3. Safety switches.
 4. Variable Frequency Drives/Controllers
 5. Magnetic Motor Controllers
 6. Control panels.

- E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- F. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- G. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
 - 1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.
- H. Include in report identification of protective device applied outside its capacity.

3.4 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. Extent of electrical power system to be studied is entire building's electrical distribution system from the BGE service down to every electrical bus/equipment indicated on the project one-line diagram including every piece of electrical distribution equipment including:
 - 1. Panelboards.
 - 2. Safety switches.
 - 3. Variable Frequency Drives/Controllers
 - 4. Magnetic Motor Controllers
 - 5. Control panels.
- F. 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).
- G. 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.
- H. 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.

3.5 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is entire building's electrical distribution system from the BGE service down to every electrical bus/equipment indicated on the project one-line diagram including every piece of electrical distribution equipment including:
 1. Panelboards.
 2. Safety switches.
 3. Variable Frequency Drives/Controllers
 4. Magnetic Motor Controllers
 5. Control panels.
- E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- F. Transformer Primary Overcurrent Protective Devices:
 1. Device must not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings must protect transformers according to IEEE C57.12.00, for fault currents.
- G. Motor Protection:
 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.

2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- I. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.
- J. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
 1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.
- K. Protective Device Evaluation:
 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
 3. Application of series-rated devices must be recertified, complying with requirements in NFPA 70.
 4. Include in report identification of protective device applied outside its capacity.

3.6 LOAD-FLOW AND VOLTAGE-DROP STUDY

- A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:
 1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
 2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.
 3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.7 MOTOR-STARTING STUDY

- A. Perform motor-starting study to analyze transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze effects of motor starting on power system stability.
- B. Prepare motor-starting study report, noting light flicker for limits proposed by IEEE 141, and voltage sags so as not to affect operation of other utilization equipment on system supplying motor.

3.8 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. Switchboards.
 - 2. Panelboards.
 - 3. Safety switches.
 - 4. Variable Frequency Drives/Controllers
 - 5. Magnetic Motor Controllers
 - 6. 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.

3.9 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

3.10 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting must be by qualified low-voltage electrical testing and inspecting agency.
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

END OF SECTION 260573

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.
- C. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; Schneider Electric USA; or a comparable product by one of the following:
 1. ABB, Electrification Business.
 2. Eaton.
- B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger:
 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 1. One leg per phase.
 2. Grounded to enclosure.
- C. Coils: Continuous windings except for taps.
 1. Coil Material: Aluminum.
 2. Internal Coil Connections: Brazed or pressure type.
- D. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound using vacuum-pressure impregnation process to seal out moisture and air.
 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 4. Environmental Protection:
 - a. Indoor: UL 50E, Type 2.
 5. Finish Color: Gray weather-resistant enamel.
- E. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- G. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.
- H. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.
- I. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.
- J. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:
1. 9.00 kVA and Less: 40 dB(A-weighted).
 2. 9.01 to 30.00 kVA: 45 dB(A-weighted).
 3. 30.01 to 50.00 kVA: 45 dB(A-weighted) for K-factors of 1, 4, and 9.
 4. 50.01 to 150.00 kVA: 50 dB(A-weighted) for K-factors of 1, 4, and 9.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.
- E. Environment: Enclosures must be rated for environment in which they are located.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base in accordance with manufacturer's published instructions.
- E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Transformer Nameplates: Label each Transformer with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573 "Power Studies." Produce a 3.5-by-5-inch self-adhesive equipment label for each low-voltage distribution transformer.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Field tests and inspections must be witnessed by Owner's representative.
- C. Perform tests and inspections:
 1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:
 - a. Visual and Mechanical Inspection.
 - 1) Inspect physical and mechanical condition.
 - 2) Inspect anchorage, alignment, and grounding.
 - 3) Verify that resilient mounts are free and that shipping brackets have been removed.
 - 4) Verify that unit is clean.
 - 5) Perform specific inspections and mechanical tests recommended by manufacturer.
 - 6) Verify that as-left tap connections are as specified.
 - 7) Verify presence of surge arresters and that their ratings are as specified.
 - b. Electrical Tests:
 - 1) Measure resistance at windings, taps, and bolted connections.
 - 2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
 - 3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
 - 4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
 - D. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.
 - E. Nonconforming Work:
 1. Transformer will be considered defective if it does not pass tests and inspections.
 2. Remove and replace units that do not pass tests or inspections and retest as specified above.
 - F. Assemble and submit test and inspection reports.

3.6 ADJUSTING

- A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.7 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Disconnecting and overcurrent protective devices.

1.2 DEFINITIONS

- A. MCCB: Molded-case circuit breaker.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Disconnecting and overcurrent protective devices.
 - 3. Include materials, switching and overcurrent protective devices, accessories, and components indicated.
 - 4. 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. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation in accordance with NECA 407 and NEMA PB 1.

PART 2 - PRODUCTS

2.1 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; Schneider Electric USA; or a comparable product by one of the following:
 - 1. ABB, Electrification Business.
 - 2. Eaton.
- B. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. 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.
- E. 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.
- F. Comply with NEMA PB 1.
- G. Comply with NFPA 70.
- H. 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. 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. Door-in-door construction with concealed hinges; secured with flush latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed
 4. Finishes:
 - a. Panels and Trim: 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.
- I. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated copper.
 - 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.
- J. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Tin-plated copper.
 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.
- K. Future Devices: Panelboards must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- L. Panelboard Short-Circuit Current Rating:
1. 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.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. 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. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).

- 3. GFEP Circuit Breakers: Class B ground-fault protection (30 mA trip).

- 4. Subfeed Circuit Breakers: Vertically mounted.

- 5. 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. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
- f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- g. Multipole units enclosed in single housing with single handle.

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 NECA 407 and 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 NECA 407 and NEMA PB 1.1.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Equipment Mounting:
 - a. Attach panelboard to vertical finished or structural surface behind panelboard.
 - 2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
 - 3. Mount top of trim 7.5 ft above finished floor unless otherwise indicated.
 - 4. Mount panelboard cabinet plumb and rigid without distortion of box.
 - 5. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
 - 6. 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.
 - 7. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes and connections to separate ground bars.
 - 8. Install filler plates in unused spaces.
 - 9. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- 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 260553 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

- D. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.
- E. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- F. Circuit Directory:
 - 1. 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.
 - 2. Create directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- G. Arc-Flash Warning Labels:
 - 1. Comply with requirements in Section 260573 "Power Studies." Produce a 3.5-by-5-inch self-adhesive equipment label for each panelboard.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Field tests and inspections must be witnessed by owner's representative.
- D. Tests and Inspections:
 - 1. 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. 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.
- E. Nonconforming Work:
 - 1. Panelboards will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.

- F. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 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 based on results of electrical power study per Section 260573 "Power Studies."

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Toggle switches.
 - 2. Receptacles with ground-fault protective devices.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Toggle switches.
 - 2. Receptacles ground-fault protective devices.

PART 2 - PRODUCTS

2.1 TOGGLE SWITCHES

- A. Toggle Switch \$2 (2-Pole Toggle Switch)
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Pass & Seymour; Legrand North America, LLC; model PS20AC2BK or a comparable product by one of 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.
 - 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: Black.
 - b. Configuration:
 - 1) Extra-heavy-duty, 120-277 V, 20 A, double pole.

2.2 RECEPTACLES GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Weather-Resistant Duplex Straight-Blade Receptacle with GFCI Device

1. Basis-of-Design Product: Subject to compliance with requirements, provide Pass & Seymour; Legrand North America, LLC; model 2097TRWRGRY or a comparable product by one of 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.
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: Gray.
 - b. Configuration: Heavy-duty, NEMA 5-20R.
 - c. Weather Resistant construction.
 - d. Self-Testing GFCI 5mA trip.

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.

3.2 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 260553 "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.

3.3 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 260553 "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 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. Perform 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 grounding circuit continuity; impedance must be not greater than 2 ohms.
5. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

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.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 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.

1.2 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. Current-limitation curves for fuses with current-limiting characteristics.
 3. Coordination charts and tables and related data.

1.3 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, provide products by one of the following:
1. Bussmann, an Eaton business.
 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 and 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 - 2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
- 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.

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. Other Branch Circuits: Class RK1, time delay.
 - 3. Control Transformer Circuits: Class CC, time delay, control transformer duty.
 - 4. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "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 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Fusible and Nonfusible switches.
 2. Molded-case circuit breakers (MCCBs).
 3. Enclosures.

1.2 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.

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 AND NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; Schneider Electric USA; or a comparable product by one of the following:
 - 1. ABB, Electrification Business.
 - 2. Eaton.
- B. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. Three pole.
 - 3. 240 and 600 V(ac).
 - 4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
 - 5. 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. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; Schneider Electric USA; or a comparable product by one of the following:
 - 1. ABB, Electrification Business.
 - 2. Eaton.
- 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. MCCBs must be equipped with device for locking in isolated position.
- E. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.

- F. 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.
- G. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

2.4 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 gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1) or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (UL 50E Types 3R, 12).
- C. Operating Mechanism: Circuit-breaker operating handle must be directly operable through front cover of enclosure (UL 50E Type 1). 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.

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. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
4. Install fuses in fusible devices.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved laminated-plastic nameplate.

B. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573 "Power Studies." Produce a 3.5-by-5-inch self-adhesive equipment label for each enclosed switch and circuit breaker.

3.5 FIELD QUALITY CONTROL

A. Perform 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 correct phase barrier installation.
- i. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

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.

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 based on results of electrical power study per Section 260573 "Power Studies."

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 262816

SECTION 262913.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Combination full-voltage magnetic motor controllers.
3. Enclosures.
4. Accessories.
5. Identification.

1.2 DEFINITIONS

- A.** CPT: Control power transformer.
- B.** MCCB: Molded-case circuit breaker.
- C.** NC: Normally closed.
- D.** OCPD: Overcurrent protective device.
- E.** SCCR: Short-circuit current rating.
- F.** SCPD: Short-circuit protective device.

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 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.

1.4 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 017823 "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.

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.

2.2 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Square D; Schneider Electric USA; or a comparable product by one of the following:
 - 1. ABB, Electrification Business.
 - 2. ABB, Motion Business.
 - 3. Eaton.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type.
 - 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.
- G. Overload Relays:
 - 1. 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.
- H. Fusible Disconnecting Means:
 - 1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
 - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.3 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.

2.4 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.

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 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. 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.
- E. 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. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved laminated-plastic nameplate.
- B. Arc-Flash Warning Labels:
 - 1. Comply with requirements in Section 260573 "Power Studies." Produce a 3.5-by-5-inch self-adhesive equipment label for each controller.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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.

- C. Motor controller will be considered defective if it does not pass tests and inspections.

END OF SECTION 262913.03

SECTION 265000 - LIGHTING

1.1 SUMMARY

A. Section Includes:

1. Luminaires.
2. Luminaire fittings.
3. Lamps.

1.2 DEFINITIONS

- A. Correlated Color Temperature (CCT): The absolute temperature (in kelvins) of a blackbody whose chromaticity (color quality) most nearly resembles that of the light source.
- B. 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. 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 battery and charger data for emergency lighting units.
 - f. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

- g. Include photometric data and adjustment factors obtained from qualified laboratory tests.
 - h. 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.
- 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' published instructions.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect exposed surface finishes on lighting equipment by applying strippable, temporary protective covering before shipping.

1.7 WARRANTY FOR LUMINAIRES

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed luminaires perform in accordance with specified requirements and agrees to repair or replace products that fail to perform as specified within extended-warranty period. Warranty must convey to Owner upon acceptance of the Work.
 - 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 luminaires perform in accordance with specified requirements and agrees to provide repair or replacement of 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 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. Marked in accordance with UL CCN HYXT, including UL 1598, for compatible power supply, installation location, and environmental conditions.
 - 2. Materials
 - a. Metal Parts: Free of burrs and sharp corners and edges.
 - b. Doors, Frames and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools.

Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses

c. Diffusers and Clobes:

- 1) Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- 2) Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

d. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

- 1) White Surfaces: 85 percent.
- 2) Specular Surfaces: 83 percent.
- 3) Diffusing Specular Surfaces: 75 percent.

3. Finishes

- a. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.2 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. 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 wire supports adjustable to 10 ft in length.

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.

C. Fluorescent Lamp:

1. Match existing fluorescent lamps in the building.

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 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 Luminaires, Lampholders, and Lamps: Article 410 of NFPA 70.
 3. 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. 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.

5. Install wiring connections for luminaires.

6. 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.

3.3 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.

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.

3.4 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 265000

SECTION 280513 - FIRE ALARM CABLES AND CONDUCTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes fire alarm cables and conductors.

1.2 DEFINITIONS

- A. Building Control Circuits: As defined in NFPA 70, Article 725 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- B. CI: Circuit Integrity.
- C. Fire Alarm Circuit Integrity Cable: Cable used in fire alarm systems to ensure continued operation of critical circuits during a specified time under fire conditions.
- D. IDC: Initiating Device Circuit.
- E. NPLFA: Non-Power Limited Fire Alarm.
- F. PLC: Power Limited Circuit
- G. PLFA: Power-Limited Fire Alarm
- H. SLC: Signaling Line Circuit

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 FIRE ALARM CABLES AND 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. Allied Wire & Cable Inc.

2. Atkore, AFC Cable Systems
 3. CommScope, Inc.
 4. Comtran Corporation.
 5. Draka Cableteq USA.
 6. Genesis Cable Products; Honeywell International, Inc.
 7. nVent (PYROTENAX).
 8. Rockbestos-Suprenant Cable Corp.
 9. West Penn Wire.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, as recommended by fire alarm system manufacturer.
1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
1. Low-Voltage Circuits: No. 14 AWG, minimum.
 2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 FIELD CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

3.2 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for installation of conduit and cable support devices.
- C. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- D. 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.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.3 INSTALLATION OF FIRE-ALARM CABLES AND CONDUCTORS

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: All fire alarm cables and conductors must be installed in metal pathway.
 - 1. Conduit must be rigid metal or electrical metallic tubing.
 - 2. Minimum conduit size: Trade size 3/4-inch.
 - 3. Compression fittings must be used.
 - 4. 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.
 - 5. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
 - 6. Signaling Line Circuits: Power-limited fire-alarm cables may be installed in the same pathway as signaling line circuits when permitted by the alarm manufacturer.
- C. Wiring within Enclosures:
 - 1. Separate power-limited and non-power-limited conductors as recommended by manufacturer.
 - 2. Install conductors parallel with or at right angles to sides and back of the enclosure.
 - 3. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 4. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks.
 - 5. Mark each terminal according to system wiring diagrams.
 - 6. 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. All cable runs shall be continuous between devices without splices.
 - 1. All terminations of conductors shall be to screw-type terminal blocks. Wire nuts, wrap-on, crimp connectors and similar devices shall not be permitted.
 - 2. All connections shall be accessible for inspection and servicing and shall be clearly identified on the Contractor's record drawings.
- F. 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.

- G. 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.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.4 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
- B. 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. 14 AWG.
 - 3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.5 CONNECTIONS

- A. Comply with requirements in Section 28 46 21 "Addressable Fire-Alarm System" 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."

3.7 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Adminstrant for Tests and Inspections:
 - 1. Administer and perform tests and inspections.
- B. Tests and Inspections:
 - 1. 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. Inspect for correct identification.
 - c. Inspect cable jacket and condition.
 - d. Continuity test on each conductor and cable.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. 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 280513

SECTION 284621 - ADDRESSABLE FIRE ALARM SYSTEM WITH ONE-WAY EMERGENCY VOICE ALARM COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit with voice/alarm signaling service module for in-building one-way fire emergency voice/alarm communications system (EVACS).
2. Manual fire-alarm boxes (pull stations).
3. System smoke detectors.
4. Heat detectors.
5. Carbon monoxide detectors.
6. Notification appliances with voice/alarm signaling loudspeakers.
7. Clear protective covers for manual fire alarm boxes.
8. Device guards.
9. Remote annunciator.
10. Graphic annunciator (map).
11. Addressable interface devices.
 - a. Control relays.
 - b. Monitoring relays.
12. Digital alarm communicator transmitter.
13. Cellular Dialer.
14. Fire alarm system surge protective devices.
15. Fire alarm system documentation cabinet.

B. Related Requirements:

1. Section 280513 "Fire Alarm Cables and Conductors" for cables and conductors for fire-alarm systems.
2. Division 7, Firestopping.

C. Obtain and pay for permits required for the installation of the fire alarm system.

1. Fire alarm contractor must provide shop drawing submittal documents to the AHJ to obtain permit.
2. Submittal must include, but not be limited to all of the following:
 - a. Scaled floor plans with room names and numbers which indicate the use of all rooms.
 - b. Fire alarm device and cable symbol legend.
 - c. Locations, including mounting heights of alarm-initiating and notification appliances.
 - d. Alarm control and trouble signaling equipment.
 - e. Fire alarm control panel and annunciator locations.
 - f. Power connections.
 - g. Battery calculations.
 - h. Size, type and number of conductors.
 - i. Voltage-drop calculations.

- j. Manufacturer's data sheets including model numbers and listing information for equipment, devices and materials.
- k. Details of ceiling height and construction.
- l. The interface of fire safety control functions.
- m. Fire alarm system riser diagram.
- n. Device to device wiring.
- o. Loudness and candela settings for every notification appliance.

1.2 DEFINITIONS

- A. AGM: Absorbed Glass Mat.
- B. ASD: Aspirating Smoke Detection, Air-Sampling Smoke Detection
- C. CO: Carbon Monoxide.
- D. dB: Decibel.
- E. ECS: Emergency Communications System
- F. EMT: Electrical Metallic Tubing.
- G. EVACS: Emergency Voice/Alarm Communications System
- H. FACP: Fire Alarm Control Panel.
- I. FACU: Fire Alarm Control Unit
- J. FAID: Fire Alarm Initiating Device.
- K. HLI: High Level Interface.
- L. LCD: Liquid Crystal Display.
- M. LED: Light-emitting diode.
- N. NICET: National Institute for Certification in Engineering Technologies.
- O. PC: Personal computer.
- P. RTI: Response Time Index.
- Q. VRLA: Valve Regulated Lead Acid.

1.3 ACTION SUBMITTALS

- A. 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.
- B. Shop Drawings: For fire-alarm system.

1. Comply with the requirements and recommendations in the "Shop Drawings (Installation Documentation)" section of the "Documentation" chapter in NFPA 72. Items to be provided include, but are not limited to the following:
 - a. Date of issue and any revision dates.
 - b. List of applicable codes and standards, including editions.
 - c. Name of protected premises, Owner, and occupant.
 - d. Name of installer and contractor.
 - e. Location (street address) of protected premises.
 - f. Plans, elevations, sections, details, and attachments to other work.
 - g. Details of equipment assemblies and support requirements. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations.
 - h. Indicate conductor sizes, termination locations and requirements, and distinguish between factory and field wiring.
 - i. Assembly and support requirement details.
 - j. Voltage-drop calculations for notification-appliance circuits.
 - k. Battery-size calculations.
 - l. Input/output matrix.
 - m. Statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 - n. Performance parameters and installation details for each detector.
 - o. Verification that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - p. Emergency voice/alarm communications system signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 - q. Legend for fire alarm device symbols and cable.
 - r. Floor plans:
 - 1) Drawn to an indicated scale.
 - 2) Include the following information:
 - a) Floor or level identification.
 - b) Point of compass (north arrow).
 - c) Graphic scale.
 - d) All walls and doors.
 - e) All partitions extending to within 15 percent of the ceiling height.
 - f) Identification of any ceiling over 10 feet in height where automatic fire detection is being proposed.
 - g) Details of ceiling geometries, including beams and solid joists, where automatic fire detection is being proposed.
 - h) Room names and numbers which indicate the use of all rooms.
 - i) System devices and component locations showing address of each addressable device.
 - j) Type, size and quantity of conductors and conduit for each circuit.
 - k) Route of cable and conduits.
 - l) Locations of system's primary disconnecting means.
 - m) Locations of monitor control interfaces to other systems.
 - n) System riser locations.
 - o) Point-to-point wiring.
 - p) Pathway class designations, including the location of any end-of-line supervisory or power devices that are required by the pathway class.
 - q) Pathway survivability level designations.

- s. Fire alarm system riser diagram with the following information coordinated with the floor plans:
 - 1) General arrangement of the system in building cross-section.
 - 2) Device-to-device wiring.
 - 3) Number of risers.
 - 4) Type and number of circuits in each riser.
 - 5) Type and number of system components and devices on each circuit on each floor or level.
 - 6) Number of conductors for each circuit.
 - 7) Pathway class designations, including the location of any end-of-line supervisory or power devices that are required by the pathway class.
 - 8) Pathway survivability level designations.

C. General Submittal Requirements:

- 1. Submittals must be approved by authorities having jurisdiction prior to submitting them to Engineer.
- 2. Shop Drawings must be prepared by persons with the following qualifications:
 - a. NICET-certified, fire-alarm technician; Level IV minimum, or a Licensed Fire Protection Engineer.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
 - 1. NICET Level III certificate or professional fire protection engineer license.
- B. Field quality-control reports.
- C. Sample Warranty: Submittal must include line-item pricing for replacement parts and labor.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
- B. Completion Documentation: In addition to items specified in Section 017823 "Operating and Maintenance Data and Instructions," provide documentation in accordance with the "Completion Documentation" section of the "Documentation" chapter in NFPA 72. Items to be provided include, but are not limited to the following:
 - 1. Written statement stating that the system has been installed in accordance with approved plans and tested in accordance with the manufacturer's published instructions and the appropriate NFPA requirements.
 - 2. Record of Completion: "Fire Alarm System Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" section of the "Inspection, Testing, and Maintenance" Chapter.
 - 3. Record (As-Built) Drawings. Submit two full-size copies to the Owner. Items to be provided include, but are not limited to the following:

- a. Current updated shop drawings reflecting the actual installation of all system equipment, components, and wiring.
 - b. Complete wiring diagrams showing connections between all devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
 - c. Riser diagram.
 - d. Device addresses.
 4. Record Copy of Site-Specific Software. Provide Software and Firmware Operational Documentation:
 - a. Software operating and upgrade manuals.
 - b. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - c. Device address list.
 - d. Printout of software application and graphic screens.
 5. Verification of Compliant Installation.
 6. Documentation of central station service.
 - C. Inspection, Testing, and Maintenance Documentation: Comply with the "Inspection, Testing and Maintenance" section in the "Documentation" chapter and the "Inspection, Testing and Maintenance" chapter in NFPA 72. Items to be provided include, but are not limited to the following:
 1. Test plan documentation.
 2. Acceptance testing documentation.
 3. Periodic inspection and testing documentation.
 4. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - a. Equipment to be tested.
 - b. Frequency of testing of installed components.
 - c. Frequency of inspection of installed components.
 - d. Requirements and recommendations related to results of maintenance.
 - e. Manufacturer's user training manuals.
 5. Manufacturer's required maintenance related to system warranty requirements.
 6. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
- 1.6 MAINTENANCE MATERIAL SUBMITTALS
- A. Keys: Provide six sets of keys to all locks at occupancy.
 1. Properly and legibly mark and tag each set of keys. Loose keys will not be accepted.
 2. Transmit keys to Facilities Management Manager for acceptance at occupancy.
 - B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.

2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors and Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper-proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fire alarm system must be installed under the supervision of persons with the following minimum qualifications:
 - a. Certified by NICET as fire-alarm Level III technician.
2. Personnel must be trained and certified by manufacturer for installation of units required for this project.

B. Source Limitations for Fire Alarm System and Components: Obtain fire alarm system from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 PROJECT CONDITIONS

A. Protect devices during construction. If devices are placed in service to protect the facility during construction, replace devices prior to final acceptance.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Noncoded, addressable system, with multiplexed signal transmission and voice/strobe evacuation.

- B. Automatic sensitivity control of certain smoke detectors.
- C. All components provided must be listed for use with the selected system.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation must be by one or more of the following devices and systems:
 - 1. Manual fire alarm boxes.
 - 2. Heat detectors.
 - 3. Smoke detectors.
- B. Fire-alarm signal must initiate the following actions:
 - 1. Continuously operate alarm notification appliances, including voice evacuation notices.
 - 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station.
 - 4. Activate voice/alarm communications system.
 - 5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 - 6. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
 - 7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 8. Record events in the system memory.
 - 9. Indicate device in alarm on the remote annunciator.
- C. Carbon monoxide signal initiation must be by carbon monoxide detectors. Carbon monoxide signal must initiate the following actions:
 - 1. Continuously operate associated CO alarm notification appliances by producing a distinctive alarm signal pattern in accordance with NFPA 72, 23.8.6.1.3.
 - 2. Occupant notification must consist of a flashing blue light with sounder at locations indicated on the drawings.
 - 3. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 - 4. Transmit supervisory alarm signal to the remote alarm receiving station.
 - 5. Record events in the system memory.
 - 6. Indicate device in alarm on the graphic annunciator.
 - 7. Actuate associated blue flashing light and sounder.
- D. Supervisory signal initiation must be by one or more of the following devices and actions:
 - 1. Duct smoke detectors.
 - 2. Carbon monoxide detectors.
 - 3. User disabling of zones or individual devices.
 - 4. Loss of communication with any panel on the 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 any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.

F. System Supervisory and Trouble Signal Actions:

1. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
2. Transmit a trouble or supervisory signal to the remote alarm receiving station.
3. Display system status on graphic annunciator and remote annunciator.
4. Record the event in system memory.

2.3 FIRE-ALARM CONTROL UNIT

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

1. Fire-Lite Alarms: Honeywell International, Inc.
2. Gamewell – FCI: Honeywell International, Inc.
3. Mircom Technologies, Ltd.
4. Notifier: Honeywell International, Inc.
5. Potter Electric Signal Company, LLC.
6. **Silent Knight: Honeywell International, Inc. (Basis of Design)**
7. SimplexGrinnell LP.

B. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.

C. Performance Criteria:

1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
2. General Characteristics:
 - a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACU and remote circuit interface panels, annunciators, and displays.
 - d. The FACU must be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system must require no manual input to initialize in the event of a complete power down condition. The FACU must provide a minimum 500-event history log.

- f. Addressable Initiating Device Circuits: The FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
 - 1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment.
 - 3. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - a. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
 - b. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
 - 4. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - a. NFPA 72 Pathway Class Designations:
 - 1) Initiating-Device Circuits (monitoring non-intelligent devices) – Class B.
 - a) Addressable monitoring modules must be located within three feet of the non-intelligent device they monitor.
 - 2) Notification-Appliance Circuits – Class B.
 - 3) Signaling-Line Circuits - Class A.
 - b. Pathway Survivability: Level 1.
 - 5. Install no more than 159 addressable detectors and 159 addressable monitor, control, or relay devices on each signaling-line circuit.
 - 6. Visual alarm appliances must flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
 - 7. Serial Interfaces are required for the following:
 - a. Central-station operation using point ID DACT.
 - b. Remote annunciators,
 - c. EVACS interface.
 - d. PC configuration.
- D. Notification Appliance Circuit:
- 1. Audible appliances must sound in a three-pulse temporal pattern, as defined in NFPA 72.
 - 2. Visual alarm appliances must flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- E. Smoke-Alarm Verification:
- 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.

3. Record events by the system printer.
 4. Sound general alarm if the alarm is verified.
 5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.]
- F. Remote Smoke-Detector Sensitivity Adjustment: Controls must select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- H. Voice/Alarm Signaling Service: Central emergency communications system with microphone, preamplifiers, amplifiers, and tone generators provided in a separate cabinet.
1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers must comply with UL 1711.
 - a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - 1) Fire alarm evacuation message must consist of ANSI S3.41 standard "temporal three" alert for two cycles, followed by the voice evacuation message, followed by two cycles of the alert tone. This process must continue until the alarm condition has been cleared, the system has been reset, or the alarm is manually silenced.
 - 2) A live voice message must override the automatic output.
 - c. The system must be capable of operating all loudspeakers at the same time.
 - d. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - e. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
 - f. The digitalized voice message must consist of a non-volatile microprocessor-based input to the amplifiers. The microprocessor must actively interrogate all circuitry, field wiring and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction, which could render the digital voice module inoperable must automatically cause the standard temporal alert tone to take over all functions assigned to the failed unit.
 - g. Messages must be approved by the Authority Having Jurisdiction (AHJ). The prerecorded messages must include, but not be limited to the following:

"May I have your attention please! May I have your attention please! There has been a fire alarm reported in the building. Please proceed to the nearest exit and leave the building."
 2. Status Annunciator: Indicate the status of various voice/alarm loudspeaker zones.

3. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
- I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters must be powered by 24-V dc source.
 1. Alarm current draw of entire fire-alarm system must not exceed 80 percent of the power-supply module rating.
- J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 1. Secondary power must be capable of operating the system under quiescent load for a minimum of 24 hours and then must be capable of operating the system during a fire or other emergency condition for a period of 15 minutes at maximum connected load.
 2. Storage Batteries:
 - a. VRLA-AGM: Valve-regulated, absorbed glass mat, lead acid.
 - b. Listed or component recognized by a nationally recognized testing laboratory.
 - c. Marked with the month and year of manufacture using the month/year format.
 - d. Batteries must be housed in the control cabinet or a separate cabinet with adequate cell separation to prevent accidental discharge.
 3. The charger must be automatic in design, adjusting the charge rate to the condition of the batteries. Battery charger must be housed in the main fire alarm control panel or the battery cabinet.
 4. Battery and Charger Capacity: Comply with NFPA 72. The battery supply must be calculated to operate its load under quiescent load for twenty-four hours with no primary power applied and, after that time, operate during a fire or other emergency condition for a period of fifteen minutes at maximum connected load. Batteries must be sized with an added 25% safety margin to allow for deterioration and aging during the life of the battery. Battery calculations must be submitted to justify the battery size.
- K. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 SURGE PROTECTION

- A. Install surge protection on normal ac power for the FACP, Auto-Dialer, Booster/NAC Panels, Amplifiers and its accessories. Comply with Division 26 Section "Surge Protective Devices for Low-Voltage Electrical Power Circuits" for auxiliary panel suppressors.
 1. Surge suppressors must be listed for use with fire alarm systems.
 2. Install surge suppressors adjacent to fire alarm equipment cabinet(s). Do not install surge suppressors inside fire alarm equipment cabinets.
- B. Install surge protection on all system wiring that leaves the interior premises of the building housing the FACP.

- C. Provide surge suppressors for all telephone or DSL connections to the fire alarm system.

2.5 MANUAL FIRE-ALARM BOXES (MANUAL PULL STATIONS)

- A. 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 an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - 2. Station Reset: Key- or wrench-operated switch.

2.6 CLEAR PROTECTIVE COVERS FOR MANUAL FIRE-ALARM BOXES

- A. Basis-of-Design: STI Stopper Model No. STI-13210FR, or approved equal.
 - 1. Description:
 - a. Clear polycarbonate shield and frame to prevent false alarms.
 - b. Surface mount. Maximum protrusion: 4 inches deep.
 - c. Without piezo horn.

2.7 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Detectors must be four-wire type.
 - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - 4. Base Mounting: Detector and associated electronic components must be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 7. Remote Viewing: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at fire-alarm control unit for, sensitivity, and alarm condition
- B. Photoelectric Smoke Detectors:
 - 1. Detector address must be accessible from fire-alarm control unit and must be able to identify the detector's location within the system and its sensitivity setting.
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
 - 1. Detector address must be accessible from fire-alarm control unit and must be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, 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.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor must have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.8 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
 1. Mounting: Adapter plate for outlet box mounting.
 2. Testable by introducing test carbon monoxide into the sensing cell.
 3. Detector must provide alarm contacts and trouble contacts.
 4. Detector must send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 5. Comply with UL 2075.
 6. Locate, mount, and wire according to manufacturer's written instructions.
 7. Provide means for addressable connection to fire-alarm system.
 8. Test button simulates an alarm condition.

2.9 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
 1. Temperature sensors must test for and communicate the sensitivity range of the device.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory-integrated audible and visual devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- B. Visual Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "ALERT" is engraved in minimum 1-inch-high letters on the lens.
 - 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 - 2. Mounting: Wall mounted unless otherwise indicated.
 - 3. For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
 - 4. Flashing must be in a temporal pattern, synchronized with other units.
 - 5. Strobe Leads: Factory connected to screw terminals.
 - 6. Mounting Faceplate: Factory finished, white.
- C. Voice/Tone Notification Appliances:
 - 1. Comply with UL 1480.
 - 2. Loudspeakers for Voice Notification: Locate loudspeakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - 3. High-Range Units: Rated 2 to 15 W.
 - 4. Low-Range Units: Rated 1 to 2 W.
 - 5. Mounting: Flush, semi-recessed, or surface mounted and bidirectional as required by location and field conditions.
 - 6. Matching Transformers: Tap range matched to acoustical environment of loudspeaker location.

2.11 GRAPHIC MAP

- A. Graphic MAP: Mounted in an aluminum frame with nonglare, minimum 3/16-inch-thick, clear acrylic cover over graphic representation of the facility.
 - 1. Graphic representation of the facility must be a CAD drawing. CAD drawing must be at 1/16-inch per foot scale or larger.
 - 2. Mount adjacent to remote LCD annunciator.

2.12 REMOTE LCD ANNUNCIATOR

- A. Description: Annunciator functions must match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions must match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Surface cabinet, NEMA 250, Type 1.

- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.13 ADDRESSABLE INTERFACE DEVICE

- A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

- C. Control Module:

1. Operate notification devices.

2.14 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter must be acceptable to the remote central station and must comply with UL 632.

- B. Functional Performance: Unit must receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals must be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter must initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter must automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter must initiate the local trouble signal.

- C. Local functions and display at the digital alarm communicator transmitter must include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

- D. Digital data transmission must include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.

7. Abnormal test signal.
8. Communication bus failure.

E. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.15 FIRE ALARM CELLULAR DIALER

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. Telular Corp. Telguard TG-7FS.
2. StarLink Fire LTE
3. Bosch

B. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. UL 864.

2. General Characteristics:

- a. Must be factory assembled, wired, and tested; ready for installation and operation.
- b. Packaging: Single, modular, NEMA 250, Type 1 metal enclosure with tamper-resistant flush tumbler lock.
- c. Normal Power Input: 120 V(ac).
- d. Secondary Power: Integral-sealed, rechargeable, 12 V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.

1) Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to transmitter, matching fire-alarm and other system outputs to message-generating inputs of transmitter that produce required message transmissions.

e. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU or from its own internal sensors or controls and must automatically transmit signal along with unique code that identifies transmitting station to remote alarm receiving station. Transmitted messages must correspond to standard designations for fire-reporting system to which signal is being transmitted and must include separately designated messages in response to the following events or conditions:

- 1) Dialer Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
- 2) System Test Message: Initiated manually by test switch within transmitter cabinet, or automatically at optionally preselected time, once every 24 hours, with transmission time controlled by programmed timing device integral to transmitter controls.
- 3) Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of transmitter normal power source, derangement of wiring of transmitter, or alarm input interface circuit or device connected to it.
- 4) Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause trouble signal to be indicated on building system.

- 5) Local Fire-Alarm-System Alarm Message: Actuated when building system goes into alarm state. Identifies device that initiated alarm.
- 6) Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when building alarm system indicates supervisory alarm.

2.16 DOCUMENTATION CABINET

- A. Description: Enclosure to accommodate standard 8-1/2-by-11-inch manuals and loose document records. Legend sheet must be permanently attached to cabinet door for system required documentation, key contact personnel, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
 1. Size documentation cabinet so that all necessary documentation will fit inside it.
 2. Documentation includes, but is not limited to Owner's manual, record drawings, record of completion form, equipment technical and product data sheets, emergency response plan, record copy of site-specific software and firmware control documentation, annual inspection testing and maintenance records, etc.
- B. Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
- C. Color: Red powder-coat epoxy finish.
- D. Labeling: Permanently screened with 1-inch-high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
- E. Security: Locked with 3/4-inch barrel lock. Provide solid 12-inch stainless steel piano hinge.

2.17 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
 1. Factory fabricated and furnished by device manufacturer.
 2. Finish: Paint of color to match the protected device.

2.18 WIRE AND CABLE

- A. Wire and cable for fire alarm systems must be UL listed and labeled as complying with NFPA 70, Article 760.

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 INSTALLATION OF EQUIPMENT

- A. Comply with NECA 305, NFPA 72, NFPA 101, IBC, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 1. Devices placed in service before 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 according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
- C. Manual Fire-Alarm Boxes:
 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 2. Mount manual fire-alarm box on a background of contrasting color.
 3. Operable part of manual fire-alarm box must be between 42 inches and 48 inches above floor level. All devices must be mounted at the same height unless otherwise indicated.
- D. Smoke- and Heat-Detector Spacing:
 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. 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 according to Annex A or Annex B in NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- E. Install a 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 the full width of duct. Tubes more than 36 inches long must be supported at both ends.
- G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

- H. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.3 PATHWAYS

- A. Pathways must be installed in rigid metal conduit or electrical metallic tubing.
- B. Exposed conduit must be painted with a red enamel stripe every 10 feet.
- C. Paint fire-alarm system junction boxes and covers red.
- D. All circuits necessary for the operation of notification appliances must be protected until they enter the evacuation signaling zone.
- E. A minimum of two distinct fire alarm audible notification appliance circuits must be provided on each floor.
- F. A minimum of two distinct visual appliance circuits must be provided on each floor.
- G. Circuit integrity cable, if used, must be installed only in EMT and must be supported in accordance with manufacturer's requirements and UL 2196.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 280513 "Fire Alarm Cables and Conductors."
- B. Ground and bond equipment in accordance with Section 260526 "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 260553 "Identification for Electrical Systems."

3.5 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions, and related to doors in smoke partitions, connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an

addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.

3.6 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 a location visible from fire-alarm control unit.
- C. Provide identification for circuit breaker serving fire alarm control unit.
 1. Provide circuit breaker with red marking in accordance with NFPA 72.
 2. Fasten phenolic nameplate at circuit breaker. Nameplate must read: "FIRE ALARM CIRCUIT."
- D. Identify power source and location of branch circuit disconnect serving fire alarm equipment. Provide engraved phenolic sign fastened to FACP "THIS PANEL FED FROM PANEL____(1)____, CIRCUIT NO.____(2)____,LOCATED IN ____ (3) ____"
 1. "(1)" Replace this blank with the name of the panelboard that supplies power to the fire alarm equipment.
 2. "(2)" Replace this blank with the branch circuit number that supplies power to the fire alarm equipment.
 3. "(3)" Replace this blank with the location of the panelboard.

3.7 GROUNDING AND BONDING

- A. Ground FACU and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.8 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction.
- B. Test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and inspections:
 1. Prepare for final test. Ensure all components of the project's fire protection systems are inspected and pre-tested prior to requesting a final inspection visit by the AHJ. Inspection deficiencies will be referenced to NFPA requirements, and/or Contract Specification requirements. Use, as a minimum, the following pre-commissioning check list:
 - ☐ NFPA 72" Fire Alarm System Record of Completion" form completed by contractor.
 - ☐ System meets contract specification requirements

- ☐ O&M Manuals provided
 - ☐ System has been inspected and pre-tested
 - ☐ Proper batteries installed
 - ☐ Circuit breaker location identified at fire alarm panel, and properly identified at breaker panel location
 - ☐ System is free of all trouble conditions
 - ☐ System has been programmed to meet specification requirements
 - ☐ Systems device text programming has been coordinated with the Owner to ensure proper device identity and location.
 - ☐ Operating instructions provided at fire alarm control panel location
 - ☐ All devices and components installed per approved shop drawings
 - ☐ All devices properly labeled and properly identified on as-builts
 - ☐ All conduit box covers in place
 - ☐ No T-Tap connections or splices in circuits
 - ☐ All T-Bar hangers in place where devices are installed on drop ceilings
 - ☐ No flexible conduit exceeds 6 feet in length
 - ☐ All concealed devices have remote lamps in visible areas
 - ☐ All control relays located within 3 feet of controlled equipment
 - ☐ All required surge suppressors properly installed (including required suppressors for F/A circuits leaving and entering buildings)
 - ☐ Fire alarm communicating properly to Owner designated central monitoring station
 - ☐ Two telephone lines arranged for F/A communications to monitor station. (one required to be dedicated and one can be shared with fire alarm line capture)
 - ☐ Cellular dialer arranged for F/A communications to monitoring station.
 - ☐ Spare parts provided
 - ☐ Systems training provided to Owner's personnel (could be done at final acceptance)
2. Visual Inspection: Conduct visual inspection prior to testing.
- a. Inspection must be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
3. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
4. Measure sound pressure levels with a sound level meter meeting ANSI S1.4a Specifications for Sound Level Meters, Type 2 requirements.
- a. Measure sound pressure levels throughout the protected area to confirm that they are in compliance with NFPA 72.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.9 DOCUMENTATION CABINET

- A. Install documentation cabinet at the fire alarm control panel.
- B. At project completion, place documents inside the documentation cabinet in accordance with NFPA 72.

3.10 MAINTENANCE SERVICE

- A. Initial 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 according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- 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.

3.11 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust and operate fire-alarm system.
- B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment.
- C. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include system and equipment descriptions, operating standards, regulatory requirements, equipment function, and operating characteristics.
 - 2. Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and maintenance service agreements.

3. Emergencies: Include instructions on procedures; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electronic systems.
- D. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- E. Provide video recordings of training modules in Digital Video Disc (DVD) format.

END OF SECTION 284621

SPECIAL PROVISIONS

Builder's Risk Insurance

- A. The Contractor shall, at his/her own cost, insure the work and keep it insured at all times during the period of construction, and until final acceptance of it by the County against loss of damage covered by an "All Risk" Builders Risk type of policy. The amount of insurance shall be the 100% estimated replacement cost of the work.
- B. The policies shall be made payable to the County and the Contractor, as their interest may appear, and the policies shall be left in the possession of the Engineer, prior to the start of construction.

S E C T I O N I I I

Permits

N/A

SECTION I V

Proposal

**This Section to be
Completed by Time of Bid**

SECTION-IV
PROPOSAL

DESCRIPTION OF WORK

Bid Opening via Teleconference WebEx: Thursday, June 26, 2025 @ 10:45 a.m. EST.

WebEx Phone Number 1-415-655-0001, Access Code Number 2319 002 0950##.

Begin Work Within Fifteen (15) Days After NOTICE TO PROCEED

Calendar Days for Completion: Two Hundred Seventy-Three (273)

Liquidated and Other Damages: FIFTEEN HUNDRED DOLLARS (\$1500.00 PER CALENDAR DAY)

Cost Group "E" (\$2,500,001 to \$5,000,000) (Prequalified contractors with a Cost Group restriction must I5tificate of Prequalification)

Work Classification: I5

TO BALTIMORE COUNTY, MARYLAND: Furnish and Install all appurtenances, labor and equipment for replacement of HVAC system. **Dundalk - District 12c7.**

The following listed Drawing Number(s) are collectively the "Drawings", and are hereby incorporated in the Contract.

<u>Workday Number</u>	<u>Drawing Number(s)</u>
10000216	2024-2439 thru 2513

A pre-bid meeting will be held on Wednesday, June 4, 2025 at 11:00 a.m. EST via WebEx. *Phone-In (Audio Only)* – 1-415-655-0001, Meeting Number 2314 061 1470##. *Video Conference* – Meeting Number 2314 061 1470 ,**Password: rqM3i3yJcF3**, go to <https://signin.webex.com/join>, or for the WebEx link go to www.baltimorecountymd.gov/departments/public-works/engineering/contracts/current-solicitations

NOTE: No successful bidder may withdraw their bid within NINETY (90) days after the opening thereof.

The Contractor hereby declares that it has carefully examined the solicitation, plans and specifications, form of contract, Special Provisions and Drawings (collectively the "Contract Documents"). The Contractor also hereby declares that it has carefully examined the September 2023 "Standard Specifications for Construction and Materials" and "Standard Details for Contraction", collectively the "Applicable County Law" and any and all Department of Public Works and Transportation revisions thereto as of the date of advertisement. The Contract Documents, the Applicable County Law and the Department of Public Works and Transportation revisions thereto are collectively the "Specifications" and are incorporated herein. Copies of any and all Department of Public Works and Transportation revisions including but not limited to the General Conditions Building Projects, are available online at www.baltimorecountymd.gov/departments/public-works/standards. Also, the Contractor has, to its satisfaction, examined the locality of the proposed work and agrees to furnish all labor, tools, materials, machinery, equipment, and other means of construction called for in the manner provided in the Specifications for the prices shown on the next page(s) and as evidenced by Contractor's signature on the last page thereof.

SCHEDULE OF PRICES

NOTE: The Bidder shall fill out this Proposal, write in the unit prices in clear numerals, and make the extensions.

For complete information concerning these items, see Specifications and contract forms.

CONTRACT PROPOSAL

North Point Library HVAC Renovation - 1716 Merritt Boulevard, Dundalk, MD 21222

CONTRACT NUMBER: 24146 PO0

WORKDAY NUMBER: 10000216

JOB ORDER NUMBER: N/A

CALENDAR DAYS: 273

CONTRACTOR: _____
ADDRESS: _____
PHONE: _____

BID ITEM	COMM. CODE		DESCRIPTION	UNIT	ESTIMATED QUANTITY	UNIT PRICE	TOTAL AMOUNT
1	0	0000	NORTH POINT LIBRARY CHILLER PLANT UPGRADE	LS	1		\$
TOTAL COST FOR CONTRACT							\$

TOTAL COST FOR CONTRACT IN WORDS

OFFICER SIGNATURE

TITLE

PROPOSAL AFFIDAVIT

1. AUTHORIZED REPRESENTATIVE

I HEREBY AFFIRM THAT:

I am the [title]_____ and the duly authorized representative of [business]_____ (the "Business") and that I possess the legal authority to make this Affidavit on behalf of myself and the Business for which I am acting.

2. PROPOSAL CERTIFICATION

THE UNDERSIGNED HEREBY ACKNOWLEDGES receipt of the following Addenda (list by number and date):

Accompanying this Proposal is a Bid Bond in an amount of 5% of the bid, the exact amount to be determined by the difference between the low bid and the next lowest bid, if two or more bids are received, or 5% of the bid if one bid is received. This guarantees payment to Baltimore County of the amount thus determined as liquidated damages in case of default in any matter specified as required before award or in any matter resulting in failure to execute and deliver an Agreement, together with Payment and Performance Bonds, after award.

3. AFFIRMATION REGARDING BRIBERY CONVICTIONS

I FURTHER AFFIRM THAT:

Neither I, nor to the best of my knowledge, information, and belief, the Business, nor any of its officers, directors, partners, or any of its employees directly involved in obtaining or performing contracts with public bodies (as is defined in Section 16-101(f) of the State Finance and Procurement Article of the Annotated Code of Maryland), has been convicted of, or has had probation before judgment imposed pursuant to Section 6-225 of the Criminal Procedure Article of the Annotated Code of Maryland, or has pleaded nolo contendere to a charge of, bribery, attempted bribery, or conspiracy to bribe in violation of Maryland law, or of the law of any other state or federal law, except as follows [indicate the reasons why the affirmation cannot be given and list any conviction, plea, or imposition of probation before judgment with the date, court, official or administrative body, the sentence or disposition, the name(s) of person(s) involved, and their current positions and responsibilities with the Business]:

4. AFFIRMATION REGARDING OTHER CONVICTIONS

I FURTHER AFFIRM THAT:

Neither I, nor to the best of my knowledge, information, and belief, the Business, nor any of its officers, directors, partners, or any of its employees directly involved in obtaining or performing contracts with public bodies, has:

(1) Been convicted under state or federal statute of a criminal offense incident to obtaining, attempting to obtain, or performing a public or private contract, fraud, embezzlement, theft, forgery, falsification or destruction of records, or receiving stolen property;

(2) Been convicted of any criminal violation of a state or federal antitrust statute;

(3) Been convicted under the provisions of Title 18 of the United States Code for violation of the Racketeer Influenced and Corrupt Organization Act, 18 U.S.C. §1961, et seq., or the Mail Fraud Act, 18 U.S.C. §1341, et seq., for acts arising out of the submission of bids or proposals for a public or private contract;

(4) Been convicted of a violation of the State Minority Business Enterprise Law, Section 14-308 of the State Finance and Procurement Article of the Annotated Code of Maryland;

(5) Been convicted of conspiracy to commit any act or omission that would constitute grounds for conviction or liability under any law or statute described in subsection (1), (2), (3), or (4) above;

(6) Been found civilly liable under a state or federal antitrust statute for acts or omissions in connection with the submission of bids or proposals for a public or private contract;

(7) Admitted in writing or under oath, during the course of an official investigation or other proceedings, acts or omissions that would constitute grounds for conviction or liability under any law or statute described above, except as follows [indicate reasons why the affirmations cannot be given, and list any conviction, plea, or imposition of probation before judgment with the date, court, official or administrative body, the sentence or disposition, the name(s) of the person(s) involved and their current positions and responsibilities with the Business, and the status of any debarment]:

5. AFFIRMATION REGARDING DEBARMENT

I FURTHER AFFIRM THAT:

Neither I, nor to the best of my knowledge, information, and belief, the Business, nor any of its officers, directors, partners, or any of its employees directly involved in obtaining or performing contracts with public bodies, has ever been suspended or debarred (including being issued a limited denial of participation) by any public entity, except as follows [list each debarment or suspension providing the dates of the suspension or debarment, the name of the public entity and the status of the proceeding, the name(s) of the person(s) involved and their current positions and responsibilities with the Business, the grounds of the debarment or suspension, and the details of each person's involvement in any activity that formed the grounds of the debarment or suspension]:

6. AFFIRMATION REGARDING DEBARMENT OF RELATED ENTITIES

I FURTHER AFFIRM THAT:

(1) The Business was not established and it does not operate in a manner designed to evade the application of or defeat the purpose of debarment pursuant to Sections 16-101, et seq., of the State Finance and Procurement Article of the Annotated Code of Maryland; and

(2) The Business is not a successor, assignee, subsidiary, or affiliate of a suspended or debarred business, except as follows: [you must indicate the reasons why the affirmations cannot be given without qualification]:

7. SUB-CONTRACT AFFIRMATION

I FURTHER AFFIRM THAT:

Neither I, nor to the best of my knowledge, information, and belief, the Business, has knowingly entered into a contract with a public body under which a person debarred or suspended under Title 16 of the State Finance and Procurement Article of the Annotated Code of Maryland will provide, directly or indirectly, supplies, services, architectural services, construction related services, leases of real property, or construction.

8. AFFIRMATION REGARDING COLLUSION

I FURTHER AFFIRM THAT:

Neither I, nor to the best of my knowledge, information, and belief, the Business, nor any of its officers, directors, members or partners, nor any of its employees, have in any way:

(1) Agreed, conspired, connived, or colluded to produce a deceptive show of competition in the compilation of the accompanying bid or offer that is being submitted;

(2) In any manner, directly or indirectly, entered into any agreement of any kind to fix the bid price or price proposal of the bidder or offeror or of any competitor, or otherwise take any action in restraint of free competitive bidding in connection with the contract for which the accompanying bid or offer is submitted;

(3) Colluded with anyone to obtain information concerning the bid that would give the Business an unfair advantage over others.

9. POLITICAL CONTRIBUTION DISCLOSURE AFFIRMATION

I FURTHER AFFIRM THAT:

The Business affirms that it is aware of, and will comply with, the provisions of Sections 14- 101 through 14-108 of the Election Law Article of the Annotated Code of Maryland, which require that every person who makes, during any 12-month period, one or more contracts, with one or more Maryland governmental entities involving cumulative consideration, or at least \$200,000.00, shall file with the State Board of Elections certain specified information to include disclosure of attributable political contributions in excess of \$500 during defined reporting periods.

10. CERTIFICATION OF CORPORATION REGISTRATION AND TAX PAYMENT

I FURTHER AFFIRM THAT:

(1) The Business is a _____(State) (Corporation), (LLC), (Partnership), (Sole Proprietor/Individual), (Other:_____), that it **is** registered in accordance with the Corporations and Associations Article of the Annotated Code of Maryland, that it **is** in good standing in the State of Maryland, and that it **has** filed all of its annual reports, together with filing fees, with the Maryland State Department of Assessments and Taxation, and that the name and address of its resident agent filed with the State Department of Assessments and Taxation is:

Name: _____

Address: _____

(If none, so state)

(2) Except as validly contested, the Business has paid, or has arranged for payment of, all taxes due the State of Maryland and Baltimore County, and has filed all required returns and reports with the Comptroller of the Treasury, the State Department of Assessments and Taxation, and the Employment Security Administration, as applicable, and will have paid all withholding taxes due the State of Maryland prior to final settlement.

11. CONTINGENT FEES

I FURTHER AFFIRM THAT:

The Business has not employed or retained any person, partnership, corporation, or other entity, other than a bona fide employee or agent working for the Business, to solicit or secure the Contract, and that the Business has not paid or agreed to pay any person, partnership, corporation, or other entity, other than a bona fide employee or agent, any fee or other consideration contingent on the making of the Contract.

12. NONDISCRIMINATION IN EMPLOYMENT STATEMENT

I FURTHER AFFIRM THAT:

During the performance of any contract awarded of which this affidavit is a part:

(1) The Business will not discriminate against any employee or applicant for employment because of race, color, religion, sex, age, national origin, marital status, sexual orientation, genetic information, or disability unrelated in nature and extent so as to reasonably preclude the performance of the employment, or because of the individual's refusal to submit to a genetic test or make available the results of a genetic test. The Business will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, age, national origin, marital status, sexual orientation, genetic information, or disability unrelated in nature and extent so as to reasonably preclude the performance of the employment, or because of the individual's refusal to submit to a genetic test or make available the results of a genetic test. Such action shall include, but not be limited to the following: employment, promotion, upgrading, demotion or transfer, rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Business agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the owner setting forth provisions of this nondiscrimination clause.

(2) The Business will, in all solicitations or advertisements for employees placed by or on behalf of the Business, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, age, national origin, marital status, sexual orientation, genetic information, or disability unrelated in nature and extent so as to reasonably preclude the performance of the employment, or because of the individual's refusal to submit to a genetic test or make available the results of a genetic test.

(3) The Business shall send to each labor union or representative of workers with which the Business has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the owner, advising the said labor union or workers' representative of these commitments, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The Business shall furnish, if requested by the County, a compliance report concerning our employment practices and policies in order for the County to ascertain compliance with the special provisions of this affidavit concerning nondiscrimination in employment.

(5) In the event of the Business's noncompliance with the nondiscrimination clause of this affidavit, the contract may be canceled, terminated, or suspended in whole or in part, and the Business may be declared ineligible for further County work.

(6) The Business shall include the special provisions outlined herein pertaining to nondiscrimination in employment in every subcontract, so that such nondiscrimination in employment provisions shall be binding on each subcontractor or vendor.

13. FOREIGN CONTRACTS

I FURTHER AFFIRM THAT:

The Business affirms that it is aware of, and will comply with, the provisions of Sections 10-2-110 Article 10. Finance, Title 2 – Purchasing, Baltimore County Code 2003, which requires that prior to the award of a contract for services under the provisions of this title, and during the entire term of a contract award, the bidder or vendor shall disclose to the County whether any services covered by the bid or contract, including any subcontracted services, will be performed outside the United States. The disclosure shall be made to the Office of Budget and Finance, Purchasing Bureau.

14. MINORITY BUSINESS ENTERPRISE AND FEMALE CONTRACTORS

THIS BUSINESS INTENDS to affirmatively seek out and consider minority business enterprises to participate in this contract as subcontractors and/or suppliers of materials and services.

THE UNDERSIGNED UNDERSTANDS AND AGREES: that any and all subcontracting of supplies and services in connection with this contract, whether undertaken before or after award of contract, will be in accordance with the Minority Business Enterprise and Female Contractor requirement included in the Bid Proposal package and incorporated herein as if fully set forth; and

THE UNDERSIGNED ALSO UNDERSTANDS AND AGREES that no subcontracting will be approved until Baltimore County has reviewed and approved the affirmative actions taken by this firm.

15. REQUIREMENTS FOR EXECUTING AFFIDAVIT & PROPOSAL

The Affidavit must be signed in ink in order for the bid to be accepted and that the Proposal must be typewritten or filled out in ink.

THE UNDERSIGNED ALSO UNDERSTANDS that:

Proposals submitted by an INDIVIDUAL must be signed by an individual.

Proposals submitted by a PARTNERSHIP must be signed by the partner who is legally authorized authority to bind the partnership. Attach a copy of the Partnership Agreement and a duly certified resolution evidencing the authority of the partner so signing on behalf of the partnership.

Proposals submitted by a CORPORATION must be signed by a legally authorized officer of the corporation and attested to by the Corporate Secretary. Attach a copy of the Articles of Incorporation, By-Laws and a duly certified Board Resolution evidencing the authority of the officer so signing on behalf of the corporation.

Proposals submitted by a LIMITED LIABILITY COMPANY must be signed by a legally authorized member of the company and attested to. Attach a copy of the Operating Agreement, Articles of Organization and a duly certified resolution evidencing the authority of the member so signing on behalf of the limited liability company.

NOTE: The contractor may file with the County a list of the names of those officers, partners or members, as applicable, having legal authority to execute documents on behalf of and legally bind the contractor, duly certified, as applicable and legally required, together with the aforesaid corporate documents, which shall remain in full force and effect until such time as the County Department of Public Works and Transportation, Construction Contract Administration is advised in writing to the contrary.

16. ACKNOWLEDGMENT

I ACKNOWLEDGE THAT this Affidavit is to be furnished to the County and may be distributed to units of (1) Baltimore County; (2) the State of Maryland; (3) other counties or political subdivisions of the State of Maryland; (4) other states; and (5) the federal government. I further acknowledge that this Affidavit is subject to applicable laws of the United States and the State of Maryland, both criminal and civil, and that nothing in this Affidavit or any contract resulting from the submission of this bid or proposal shall be construed to supersede, amend, modify or waive, on behalf of Baltimore County, or the State of Maryland or any unit of the State of Maryland having jurisdiction, the exercise of any statutory right or remedy conferred by the Constitution and the laws of Maryland with respect to any misrepresentation made or any violation of the obligations, terms and covenants undertaken by the Business with respect to (a) this Affidavit, (b) the contract, and (3) other Affidavits comprising part of the contract.

I DO SOLEMNLY DECLARE AND AFFIRM UNDER THE PENALTIES OF PERJURY THAT THE CONTENTS OF THIS AFFIDAVIT ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE, INFORMATION, AND BELIEF.

WITNESS/ATTEST:

_____	By: _____
Date: _____	Name: _____
	Title: _____
	(Authorized Representative and Affiant)

BID BOND

Principal

Business Address of Principal

Surety

Obligee: **BALTIMORE COUNTY, MARYLAND**
A body corporate and politic

A Corporation of the State of _____ and authorized to do business in Maryland

Five Percent of Bid Amount \$ _____ 5% of Bid

Penal Sum of Bond [shall be determined pursuant to latest revised Specification / G.P. 2.07 (2000 Ed.)]

North Point Library HVAC Renovation
Contract Name

24146 PO0
Contract Number/Proposal Item Number

KNOW ALL MEN BY THESE PRESENTS, that we, the Principal, above named, and Surety, above named, and authorized to do business in the State of Maryland, are held and firmly bound unto the Obligee, above named, in the penal sum of the amount stated above, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION is such that if the aforesaid Principal is the apparent low bidder and complies with all specified matters required before award or if the aforesaid Principal is awarded the contract, the said Principal will, within the time required, execute and deliver to the Obligee a formal contract and good and sufficient payment and performance bonds in the form provided by the Obligee, then, this obligation to be void; otherwise the Principal and Surety will, upon demand, pay unto the Obligee the entire Penal Sum of this Bid Bond as liquidated damages.

THE SURETY FURTHER GUARANTEES No Proposal will be considered unless accompanied by a guaranty of the amount specified in the Proposal in the form of either a certified check, bank cashier's check or a Bid Bond on the form provided therein or an exact facsimile thereof. The Bid Bond must be executed by a Surety that is, as of the date of the Bid: (a) licensed in the State of Maryland, (b) rated "B" or better by the A.M. Best Company, (c) on federal funded projects, authorized by the underwriting limitation contained in the U.S. Department of the Treasury Circular 570, as amended, to guaranty the amount of the Bid, and (d) in good standing as determined by the County's Engineer. The Bid Bond must guaranty payment to the County of liquidated damages as follows: (a) if only one Bid is received, the guaranteed payment shall be five (5%) percent of the Bidder's Bid amount, (b) if two or more Bids are received, the guaranteed payment shall be the difference between the Bidder's Bid amount and the next lowest Bid amount, subject to the limitation that the guaranteed payment not be greater than five (5%) percent of the Bidder's Bid amount. This Bid Bond is required in case the successful Bidder, after issuance of notice of Award, fails to comply, timely and completely, with each of the requirements set forth under Section GP-3.04.

Signed and sealed _____
Date

IN WITNESS WHEREOF, the above-bounded parties have executed this instrument under their several seals on the date indicated above, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

In Presence of:

Individual Principal

Witness: _____

as to: _____ (SEAL)

Print Name: _____

Print Name: _____

Corporate Principal

In Presence of:

(Name of Corporation)

Witness: _____

By: _____

Print Name: _____

Print Name: _____ (SEAL)

Title: _____

Surety

(Name of Surety)

Business Address: _____

Witness: _____

By: _____ Affix

Print Name: _____

Print Name: _____ Corporate

Title: _____ Seal

**BALTIMORE COUNTY
PREVAILING WAGE AND LOCAL HIRING**

AFFIDAVIT

(Project Name) _____

Proposal No.: _____

Project No.: _____

On behalf of _____, I do solemnly declare and affirm,
(Contractor)
under penalty of perjury, that to the best of my knowledge, information, and belief:

1. I have submitted all documentation in accordance with Baltimore County Code § 10-2- 506 and § 10-2-507 regarding the prevailing wage and local hiring laws and requirements of the prevailing wage guidelines located at ([Prevailing Wage and Local Hire Laws](#)), and acknowledge that I have read and agree to all provisions of said law, as amended, and have a continuing obligation to be compliant with the law and any changes to the law.

2. I shall not knowingly provide any false information relating to payroll documentation and/or hiring of local employees for capital improvement contracts that are subject to the prevailing wage and/or local hiring laws of Baltimore County. I further attest and certify that all documentation relating to the same will be accurate and complete and will remain accurate and complete on an ongoing basis, and will reflect the payroll and/or local hiring status of contractors, subcontractors, apprentices, and independent contractors performing work for the Contract (contract number _____). I acknowledge that I have been informed and am aware of the foregoing requirements and that I am authorized to make this certification on behalf of myself and all subcontractors and parties performing work pursuant to this Contract.

3. I certify and attest that I am an officer or agent of the Contractor or subcontractor who supervises the payment of employees. I understand and agree that all documentation related to prevailing wages and/or local hiring required by law shall be submitted to Baltimore County's Prevailing Wage Administrator or designee before any surety is released or final payment due under the terms of the Contract is made.

4. I further certify and attest that I will have personal knowledge of the wages paid to all employees of _____ for work performed on the Contract and of all of the hours worked, and that I am an authorized agent of the Contractor and assume responsibility for my actions.

5. I further certify and attest that _____ will comply with prevailing wage rates set by the State of Maryland as the same apply to the Contract and are a part of the bid documents and Contract, and that _____ will comply with applicable local hiring requirements.

6. I attest and certify that, if the Contract is subject to the local hiring requirement under §10-2-507 of the Baltimore County Code, _____ will make best efforts to ensure that residents of Baltimore County constitute at least 51% of the new hires made for the Contract, subject to all exceptions allowable by law.

7. I certify and attest that, if the Contract is subject to prevailing wage requirements, no rebates or deductions will be made, directly or indirectly, from any wages paid in connection with the Contract, other than those provided for by law.

8. I certify and attest that, if awarded the Contract and if the Contract is subject to prevailing wage law, I will submit certified payroll to the County through its electronic compliance system or as instructed by the Prevailing Wage and Local Hire Unit.

9. I certify that if awarded the Contract, I will provide a list of subcontractors who will participate as a beneficiary of this project to the agency and the Prevailing Wage and Local Hire Unit at PrevailingWage@baltimorecountymd.gov.

10. I understand that no funds will be dispersed by the County until an Employment Analysis has been issued to the Prevailing Wage and Local Hire Unit in compliance with the local hire law. The Employment Analysis will include how many jobs will be required to complete the project; how many current employees are available to complete the project, and how many of those jobs will require new hires.

Contractor/Bidder/Offeror

By

Printed Name

Printed Title

Date

Phone

License Number

Business Email

BALTIMORE COUNTY, MARYLAND

Prevailing Wage and Local Hiring Contract Requirements and Policies

The Contractor and all Subcontractors must comply with the Prevailing Wage and Local Hiring Laws, contained in Baltimore County Code § 10-2-506 and § 10-2-507, respectively, as amended. Prevailing wage means the wage rate paid by employers that is determined by a governmental authority, based upon a particular geographic area, for a given class of labor and type of project. The County will use the prevailing wage established by the State of Maryland (the "State") Department of Labor for state funded construction contracts in the County at the time of award. These rates include the basic hourly rate and fringe benefits. Apprentices must be paid at least the rate that the State's Apprenticeship and Training Council sets for an apprentice in the trade involved, based on a percentage of the prevailing wage rate in that trade. Any Contractor that is subject to the prevailing wage or local hiring law will be required to agree to the below provisions:

For the purposes of these requirements, an employee means an apprentice, laborer or mechanic employed by a contractor or subcontractor on a capital improvement project with a value of over \$300,000 or a County-subsidized capital project with a value over \$5,000,000.

Capital Improvement Project does not include blanket order or open-end agreements, capital improvement projects subject to a federal or state prevailing wage law, awarded without competition; with another governmental entity; to the extent the contractor is precluded from compliance by the terms of any federal or state law, contract or grant; entered into pursuant to Baltimore County Code § 10-2-310(e); entered into as a joint or cooperative purchase; or entered into as an emergency purchase.

The purpose of a prevailing wage is to ensure that contractors institute local hiring practices for Capital Improvement contracts and Capital Projects under certain circumstances as required by law, and that the Contractor's employees who work on capital improvement contracts are paid the going rate for their services. The prevailing wage rates are established by the State of Maryland Department of Labor and apply to all of the Contractor's employees and any and all Subcontractors. The Contractor and all Subcontractors must comply with all of the requirements of the Prevailing Wage Law including, but not limited to, the following:

1. Pay employees the prescribed rate as annually established by the State's Department of Labor; the prevailing wage rates in effect on the date a solicitation is issued and will apply throughout the term of a contract resulting from that solicitation. Contractor or subcontractors may NOT split or subdivide a capital improvement contract, pay an employee through a third party, treat an employee as a subcontractor or independent contractor to avoid any requirement of the County's prevailing wage law; or employ an individual classified as a helper or trainee to perform direct and measurable work on a capital improvement contract.

2. Pay employees at a rate equal to or more than the prevailing wage rate currently in effect for the type of work performed.

3. Pay employees overtime for work (I) more than eight hours in any single calendar day; (II) more than 40 hours in a work week; or (III) on a Sunday or a legal holiday.

4. Classify employees in their proper work classification in conformance with the schedule established by the State's Department of Labor.

5. May only make fair and reasonable deductions that are (a) required by law; (b) authorized in a written agreement between an employee and contractor or subcontractor signed at the beginning of employment (any deductions taken from employee paychecks including healthcare, pension, 401K, IRA, etc., child/spouse support, or tax levies); and submitted by the contractor or subcontractor to the Director of the County's Prevailing Wage Program; or required or allowed by a collective bargaining agreement between a bona fide labor organization and a contractor or subcontractor.

Electronically submit a certified copy of payroll records through the County's designated certified payroll and compliance system within 14 days after the end of payroll week ending date, to verify that Prevailing Wage rates have been paid to employees.

6. Backup documentation may be required upon demand from the County to be submitted for all 3rd party benefits being claimed, to include, but not limited to: *one month's healthcare transmittal showing employee name and amount company pays on their behalf, company vacation/sick policy, etc. or if Union, a Union transmittal for one month in which work has been performed.*

7. Retain records for a period of five (5) years after the work is completed and permit the Director of the County Prevailing Wage Program, or his/her designee, to inspect the payroll records at a reasonable time and as often as necessary.

8. Payroll records shall contain a statement signed by the contractor or subcontractor (including tiered subcontractors) certifying that the payroll records are complete and correct; the wage rates are not less than required by the Prevailing Wage Law; and the rate of pay and classification for each employee accurately reflects the work the employee performed.

9. All payroll records shall include the name, address, telephone number and email address of the contractor or subcontractor; the name and location of the job; and each employee's name, current address, unless previously reported; specific work classification; daily basic time and overtime hours; total basic time and overtime hours for the payroll period; rate of pay; fringe benefits by type and amount; and gross wages, and any deductions taken from employees' paychecks including, but not limited to, healthcare, pension/401K/IRA. Late submission of copies of any payroll records may be deemed deficient by the County until the required records are provided, and the County may postpone processing payments due under the Contract or under an agreement to finance the Contract.

10. Submit to random or regular audits and investigation of any complaint of a violation of the County's Prevailing Wage and Local Hiring Laws and requirements.
11. Make best efforts to fill at least 51% of new jobs required to complete the capital improvement contract or capital project with Baltimore County residents.
12. Submit monthly reports to the Director of the County's Prevailing Wage Unit relating to local hiring with respect to capital improvement contracts over \$300,00 or County-subsidized capital construction projects receiving assistance over \$5,000,000, that includes (a) the number of new hires needed for the contract or project, (b) the number of County residents hired during the reporting period, (c) the total number of all employees hired during the contract period, (d) best efforts made to fill open positions with County residents, and (e) 5) for new hires: name, last four (4) digits of the social security number, job title, hire date, address and referral source.
13. Agree that any and all disputes will be handled as set forth in the County's Prevailing Wage and Local Hire as a condition of award.
14. In the event the County determines that a provision of the Prevailing Wage and/or Local Hire Law has been violated, the County shall issue a written decision, including appropriate sanctions, and may withhold payment due the Contractor in an amount sufficient to pay each employee of the Contractor or any subcontractors the full amount of wages due under the Prevailing Wage Law, and an amount sufficient to satisfy a liability of the Contractor for liquidated damages as provided under the Prevailing Wage Law, pending a final decision on the violation by the County. The Contractor may appeal a written decision of the Director of the County's Prevailing Wage Unit that the Contractor violated a provision of the Prevailing Wage and/or Local Hire Law, to the Office of Administrative Hearings ("OAH"), within ten (10) working days after receiving a copy of the decision. OAH will conduct a hearing upon the receipt of a timely appeal. If no appeal, the decision of the Director of the County's Prevailing Wage Unit or his/her designee becomes final. A Contractor who is found to have violated the provisions of the Prevailing Wage or Local Hiring Laws intentionally, may not be awarded a County contract or work on any County project for a period of one year from the date of the OAH determination.
15. May not discharge, or otherwise retaliate against, an employee for asserting any right under the Prevailing Wage Law or for filing a complaint of a violation;
16. An aggrieved employee is a third-party beneficiary of the Contract and may by civil action recover the difference between the prevailing wage for the type of work performed and the amount actually received, with interest and a reasonable attorney's fee.
17. Each Contract subject to the Prevailing Wage and Local Hire Laws may specify the payment of liquidated damages to the County by the Contractor for any noncompliance with the Prevailing Wage and Local Law. Liquidated damages are:
 - a. \$10 for each calendar day that the payroll records are late (payrolls are to be submitted no later than 14 days after the week ending date shown on Certified Payroll Record CPR);
 - \$20 for each day that an employee is misclassified and/or paid less than the prevailing

wage rate; and a civil penalty of \$50 per violation of the requirement to post the prevailing wage rates at the work site.

- b. \$50 per month for each month the Local Hire report is not submitted by the last day of the existing month due.

These liquidated damages are solely related to prevailing wage and local hiring compliance and do not negate any other remedies available or set forth in the Contract, including delay damages or actual damages. These remedies are separate from, in addition to, and not in lieu of, any remedies available and set forth in the Contract, or at law, for other breaches or defaults under the Contract.

- 18. Where the initial Contract Sum is \$300,000 or below, but it is subsequently increased and exceeds \$300,000 due to an approved Contract Modification, the amount of any such Contract Modification that causes the Contract Sum to exceed \$300,000 is subject to the Prevailing Wage and Local Hiring Laws.
- 19. The Contractor and all subcontractors must post a clearly legible statement of each prevailing wage rate in a prominent and easily accessible place at the Work Site during the entire time Work is being performed, in English and any other language that is primarily spoken by the employees, at the Work Site.
- 20. A contract may include the actual cost of health and dental insurance, pension or retirement plan, paid time off such as vacation or sick days and life insurance. In calculating the cost per hour, divide the annual cost of benefits by 2,080 hours for each employee. Other benefits such as the use of a company vehicle, cell phones, lodging reimbursement, company owned tools **may not be credited towards the fringe benefit amount.**
- 21. All apprentices must be registered with the Maryland Apprenticeship and Training Council, V.A., or US DOL as well as be currently enrolled in, and attending appropriate classes, to which is considered “actively enrolled”. Only actively enrolled apprentices may be employed on the project at the apprentice prevailing wage rate.

Classification	Modification Reason	Basic Hourly Rate	Borrowed From	Fringe Benefit Payment
BALANCING TECHNICIAN	AD	\$47.92		\$24.44
BRICKLAYER	AD	\$37.50		\$14.78
CARPENTER	AD	\$34.41		\$14.49
CARPENTER - SHORING SCAFFOLD BUILDER	AD	\$34.41		\$14.49
CARPET LAYER	AD	\$34.12		\$14.86
CEMENT MASON	AD	\$25.00	510	\$1.94
COMMUNICATION INSTALLER TECHNICIAN	AD	\$36.37		\$12.89
DRYWALL - SPACKLING, TAPING, & FINISHING	AD	\$34.41		\$14.49
ELECTRICIAN	AD	\$47.13		\$21.94
ELEVATOR MECHANIC	AD	\$56.36		\$45.50
FIRESTOPPER	AD	\$29.81		\$10.08
GLAZIER	AD	\$35.60		\$14.41
INSULATION WORKER	AD	\$40.02		\$19.92
IRONWORKER - FENCE ERECTOR	AD	\$40.02		\$19.92
IRONWORKER - ORNAMENTAL	AD	\$31.17	510	\$24.38
IRONWORKER - REINFORCING	AD	\$29.20	510	\$23.57
IRONWORKER - STRUCTURAL	AD	\$33.12		\$25.63
LABORER - AIR TOOL OPERATOR	AD	\$24.46		\$9.69
LABORER - ASPHALT PAVER	AD	\$24.46		\$9.69
LABORER - ASPHALT RAKER	AD	\$22.63		\$4.88
LABORER - BLASTER - DYNAMITE	AD	\$24.46		\$9.69
LABORER - BURNER	AD	\$24.46		\$9.69
LABORER - COMMON	AD	\$22.63		\$4.88
LABORER - CONCRETE PUDDLER	AD	\$22.63		\$4.88
LABORER - CONCRETE SURFACER	AD	\$24.46		\$9.69
LABORER - CONCRETE TENDER	AD	\$22.63		\$4.88
LABORER - CONCRETE VIBRATOR	AD	\$22.63		\$4.88
LABORER - DENSITY GAUGE	AD	\$22.63		\$4.88
LABORER - FIREPROOFER - MIXER	AD	\$22.63		\$4.88
LABORER - FLAGGER	AD	\$22.63		\$4.88
LABORER - GRADE CHECKER	AD	\$22.63		\$4.88
LABORER - HAND ROLLER	AD	\$22.63		\$4.88
LABORER - HAZARDOUS MATERIAL HANDLER	AD	\$24.46		\$9.69
LABORER - JACKHAMMER	AD	\$22.63		\$4.88
LABORER - LANDSCAPING	AD	\$22.63		\$4.88
LABORER - LAYOUT	AD	\$22.63		\$4.88
LABORER - LUTEMAN	AD	\$22.63		\$4.88
LABORER - MASON TENDER	AD	\$24.46		\$9.69
LABORER - MORTAR MIXER	AD	\$22.63		\$4.88
LABORER - PIPELAYER	AD	\$24.46		\$9.69
LABORER - PLASTERER - HANDLER	AD	\$22.63		\$4.88
LABORER - SCAFFOLD BUILDER	AD	\$24.46		\$9.69
LABORER - TAMPER	AD	\$22.63		\$4.88
MECHANICAL SYSTEMS SERVICE TECH - ELECTRICAL SYSTEMS	AD	\$46.21	510	\$24.90

MECHANICAL SYSTEMS SERVICE TECH-HVAC SYSTEMS	AD	\$46.21		\$24.90
MECHANICAL SYSTEMS SERVICE TECH-PLUMBING SYSTEMS	AD	\$46.21		\$24.90
MECHANICAL SYSTEMS SERVICE TECH - REFRIGERATION SYSTEMS	AD	\$52.27	003	\$24.58
MILLWRIGHT	AD	\$38.61		\$17.21
PAINTER	AD	\$28.55		\$11.87
PAINTER-INDUSTRIAL	AD	\$35.55		\$15.28
PILEDRIIVER	AD	\$36.60		\$16.78
PLUMBER	AD	\$46.21		\$24.90
POWER EQUIPMENT OPERATOR - BACKHOE	AD	\$33.00	510	\$13.55
POWER EQUIPMENT OPERATOR - BROOM / SWEEPER	AD	\$32.23	510	\$14.62
POWER EQUIPMENT OPERATOR - BULLDOZER	AD	\$34.18		\$14.62
POWER EQUIPMENT OPERATOR - CONCRETE PUMP	AD	\$44.35		\$0.00
POWER EQUIPMENT OPERATOR - CRANE	AD	\$41.00		\$18.10
POWER EQUIPMENT OPERATOR - CRANE - TOWER	AD	\$41.00		\$18.10
POWER EQUIPMENT OPERATOR - DRILL - RIG	AD	\$33.16		\$14.15
POWER EQUIPMENT OPERATOR - EXCAVATOR	AD	\$34.18		\$14.62
POWER EQUIPMENT OPERATOR - FORKLIFT	AD	\$34.18		\$14.62
POWER EQUIPMENT OPERATOR - GRADALL	AD	\$34.00	510	\$13.55
POWER EQUIPMENT OPERATOR - GRADER	AD	\$34.18		\$14.62
POWER EQUIPMENT OPERATOR - GUARD RAIL POST DRIVER	AD	\$23.50		\$5.07
POWER EQUIPMENT OPERATOR - LOADER	AD	\$34.18		\$14.62
POWER EQUIPMENT OPERATOR - MECHANIC	AD	\$36.24		\$14.62
POWER EQUIPMENT OPERATOR - MILLING MACHINE	AD	\$30.58	510	\$13.55
POWER EQUIPMENT OPERATOR - PAVER	AD	\$32.10	510	\$13.55
POWER EQUIPMENT OPERATOR - ROLLER - ASPHALT	AD	\$32.10	510	\$13.55
POWER EQUIPMENT OPERATOR - ROLLER - EARTH	AD	\$28.60		\$14.62
POWER EQUIPMENT OPERATOR - SCREED	AD	\$30.00	510	\$11.80
POWER EQUIPMENT OPERATOR - SKID STEER (BOBCAT)	AD	\$32.23		\$14.62
POWER EQUIPMENT OPERATOR-VACUUM TRUCK	AD	\$37.50		\$14.85
RESILIENT FLOOR	AD	\$34.12		\$14.86
SHEETMETAL WORKER (INCLUDING METAL ROOFING)	AD	\$47.92		\$24.44
SPRINKLERFITTER	AD	\$42.32	510	\$26.05
SPRINKLERFITTER/PIPEFITTER	AD	\$46.21		\$24.90
STONE MASON	AD	\$44.30	510	\$21.22
TILE & TERRAZZO FINISHER	AD	\$28.09		\$12.59
TILE & TERRAZZO MECHANIC	AD	\$33.41		\$14.24
TRUCK DRIVER - DUMP	AD	\$17.64	510	\$1.92
TRUCK DRIVER - FLATBED	AD	\$20.94		\$7.63
TRUCK DRIVER - LOWBOY	AD	\$29.68	510	\$10.51
TRUCK DRIVER - TACK/TAR TRUCK	AD	\$27.35	510	\$8.97

BALTIMORE COUNTY, MARYLAND
USE OF MINORITY BUSINESS ENTERPRISES AND WOMEN'S BUSINESS ENTERPRISES
IN
COUNTY CONTRACTS
MWBE Plan Package



Division of Diversity, Equity and Inclusion
The Jefferson Building
105 West Chesapeake Avenue
Towson, Maryland 21204
410-887-3407

www.baltimorecountymd.gov/go/mwbe



PROSPECTIVE BIDDERS/OFFERORS

Baltimore County Executive Order 2022-005 Use of Minority Business Enterprises and Women's Business Enterprises states:

SECTION 6. BID REQUIREMENTS.

- (A)(1) All bidders shall submit a list of all subcontractors contacted in preparation of their bid package or proposal.
- (2) The list shall include the service to be performed, bid amount, and the race/ethnicity/gender of the business owner(s).
- (B)(1) All bidders shall submit a list of all subcontractors to be used on a county contract in the bid package.
- (2) This list shall include all subcontractors (both MWBE and non-MWBE) used, the service to be performed, the total amount to be paid, and the race/ethnicity/gender of the owner.

If the solicitation includes a MWBE **subcontracting** goal, you **MUST** demonstrate “**Good Faith**” **effort** either by:

1. Complete and sign FORM A, FORM B (to include FORM B-Prime if MWBE Prime wishes to count towards the goal) and FORM C **listing all subcontractors** with the initial bid submission.
 - a. *All Forms must be completed and signed. However, FORM C **MUST** be completed and signed by both the prime and the MWBE subcontractor.*
- OR**
2. If you are unable to meet any portion of the goal, you **MUST** do one of the following:
 - a. If you are requesting a **partial waiver**, complete and sign FORM A with initial bid submission. FORM B (to include FORM B-Prime if MWBE Prime wishes to count towards the goal) and FORM C (**listing all subcontractors**). In addition, complete, sign and submit FORM D and FORM E **accompanied with all supporting documentation** for the portion of the goal that will not be achieved as specified on FORM A.
 - b. If you are requesting a **full waiver**, complete and sign FORM A indicating your intent to request a full waiver **accompanied with a completed and signed FORM C listing all subcontractors**, FORM D and FORM E **accompanied with all supporting documentation**. **This MUST be submitted with the initial bid as specified on FORM A.**
 - c. *All Forms must be completed and signed. FORM C and FORM D **MUST** be completed and properly signed **by both the Prime AND the MWBE subcontractor(s).***

NOTE: The MWBE **subcontracting** goal applies to **ALL** prime/general contractors including certified and non-certified minority and women owned firms. **However, a Minority-owned or a Women-owned prime may self-perform up to 50% of MWBE subcontracting goal set in the solicitation. The MWBE primes that wish to count towards the goal must list themselves on all appropriate forms.**

12/2023

BALTIMORE COUNTY, MARYLAND

MWBE PARTICIPATION SUMMARY

Executive Order: Minority Business Enterprises and Women Business Enterprises (MWBE) shall have the maximum opportunity to participate in the performance of contracts financed in whole, or in certain circumstances, in part with County funds. Accordingly, on December 6, 2022, the County Executive adopted the EXECUTIVE ORDER No. 2022-005 addressing MWBE participation in County contracts. The December 6, 2022 Executive Order may be found on the Baltimore County website at www.baltimorecountymd.gov/go/mwbe.

Each Contract: The County shall establish a minimum MWBE participation amount for each contract, as applicable.

Bidder/Offeror Responsibility: The bidder/offeror shall ensure that MWBE participation occurs in accordance with the contract requirements and the County Executive's Executive Order. All bidder/offerors shall ensure that MWBE have the maximum opportunity to compete for and perform County contracts, as applicable. Baltimore County, Maryland, and/or its bidder/offerors and contractors shall not discriminate on the basis of race, color, national origin, disability or sex in the award and performance of any County contract.

Mobilization Payments: For subcontractors, project start-up costs can also be significant. A subcontractor that has limited resources and access to credit may find that start-up expenses inhibit its ability to bid County contracts. Under circumstances where mobilization payments are approved for the prime contractor, the subcontractor should be paid an amount equal to their participation percentage no later than five (5) business days before they are required to mobilize to perform the contracted work.

Mobilization costs represent pre-contract costs incurred by a contractor to prepare a job site before the actual commencement of the contract. These costs can include movement of personnel and equipment to the project site and for the establishment of the Contractor's offices, buildings, and other facilities necessary to begin work.

APPROVED MWBE LISTINGS

Published compilations of approved and certified MWBE, contractors, subcontractors, material suppliers, etc. include:

DIRECTORY OF MINORITY BUSINESS ENTERPRISE (MDOT):

<https://marylandmdbe.mdbecert.com>

MINORITY BUSINESS DIRECTORY OF THE CITY OF BALTIMORE:

<https://baltimorecity.diversitycompliance.com>

BIDDER/OFFEROR'S ACTIONS

Seeking Firms:

The bidder/offeror will seek commitments by subcontract or otherwise from MWBE firms for supplies and/or services, any combined value of which equals or exceeds the required percentage of MWBE participation goal for the County contract. However a MWBE Prime that affirms its MWBE status on the Minority and/or Women Prime Participation Affidavit may count up to 50% of the goal.

Expenditures for Materials and Supplies:

A bidder/offeror may count toward its MWBE contract requirements all expenditures for materials and supplies obtained from MWBE suppliers and manufacturers, provided that the MWBE firm is furnishing and installing the materials and is certified to perform these services. If the MWBE firm is only being used as a supplier, wholesaler and/or regular dealer or is not certified to install the supplies/materials, for purposes of achieving the MWBE participation goal, you may only count sixty percent (60%) of the value of the subcontract for these supplies/products (60% Rule). To apply the 60% Rule, first divide the amount of the subcontract for these supplies/products only (not installation) by the total Contract value. Then, multiply the result by sixty percent (60%) and insert the percentage in the Percent of Total Contract field of Form B Subcontractor Participation Schedule.

BALTIMORE COUNTY, MARYLAND **MWBE PARTICIPATION SUMMARY**

Information to be supplied: All bidder/offers shall submit the following information to the County at the time of bid submission:

1. The name of an employee designated as the bidder/offers's liaison to the County's Minority Business Enterprise Office.
2. The following forms shall be completed and submitted:
 - Certified MWBE Utilization and Fair Solicitation Affidavit (**Form A**): from among those names appearing in the Approved MWBE Listings (excepting Federal Highway Administration projects, which exclusively require DBE approved and certified by the Maryland Department of Transportation MBE Advisory Committee);
 - A Subcontractor Participation Schedule (**Form B**) completed by the prime contractor for each MWBE listed on the Form.
 - A MWBE Prime Participation Schedule (Form B-Prime) completed by a MWBE prime contractor if the firm wishes to self-perform up to 50% of the MBE/WBE goal.
 - A MWBE Disclosure and Participation Statement (**Form C**) completed and signed by the prime contractor and MWBE firm for each MWBE listed on the Form. Form C **must match** what is stated on Form B.
 - If applicable, MWBE Subcontractor Unavailable Certificate (**Form D**) completed and signed by the prime contractor and MWBE for each MWBE listed on the Form.
3. If applicable, MWBE Outreach Efforts - Compliance Statement (**Form E**) completed and signed by the Bidder/Offers. The prime shall submit a list of all subcontractors.
4. For DPW contracts, if the bidder/offers intends to fulfill the MWBE requirements by use of a joint venture, he/she must submit a Joint Venture Disclosure Affidavit (**Form D-EEO-006-A** and **B**) showing the extent of MWBE participation. If a bidder/offers intends to use a MWBE joint venture as a subcontractor to meet its MWBE requirements, the affidavit must be submitted through the bidder/offers by the proposed subcontractors and signed by all parties.
5. If the bidder/offers's proposed MWBE participation does not meet the MWBE contract requirements, information sufficient to demonstrate that the bidder/offers has made every effort to meet the requirements must be submitted. (See DETERMINATION OF BID RESPONSIVENESS hereafter)

RECORDS AND REPORTS

Returning Records: The bidder/offers must keep such records as are necessary to determine compliance with its MWBE utilization requirements:

1. The MWBE and non-minority contractors, type of work being performed, actual values of work and services.
2. Documentation of all correspondence, contacts, telephone calls, etc., to obtain MWBE services for the contract.
3. All prime contractors and MWBE sub-contractors are required to report monthly, by the 10th of each month, to the County through an online system called PRISM. If the contractor cannot submit his/her report on time, he/she will notify the County MWBE office and request additional time to submit the report. Failure of the contractor to report in a timely manner may result in a finding of noncompliance. The County in its sole discretion and/or upon written request may require additional reports regarding MWBE. In the event you are not able to enter your payments in PRISM, a spreadsheet is attached for your use. Please be sure to list the PO for each invoice/ payment reported and include in your submission any corresponding documentation (e.g. copies of invoices or cancelled checks).

Retaining Records: All MWBE records must be retained for 3 years following the expiration or any earlier termination of the contract and shall be available for inspection and photocopying by the County.

Investigation and Notification: Whenever the County believes the bidder/offers, contractor, or any subcontractor may not be operating in compliance with the MWBE requirements, the County may, in its sole discretion, conduct an investigation. If the County finds the bidder/offers, contractor, or any subcontractor is not in compliance with the MWBE requirements, the County may exercise any and all rights and remedies available to the County, under the contract, at law or equity, as deemed applicable and appropriate by the County in its sole discretion.

BALTIMORE COUNTY, MARYLAND **MWBE PARTICIPATION SUMMARY**

DETERMINATION OF BID RESPONSIVENESS

Request for Deviation: If the bidder/offeror is unable to procure from MWBE firms (by subcontract or otherwise), supplies and services, any combined value of which equals the required percentage of the total value of the contract, the bidder/ offeror may request, in writing, a deviation or waiver of the contract requirements. To obtain such a waiver, the bidder/ offeror must submit the following information at the time bids are due:

1. The request for waiver request shall include (1) a signed unavailability statement (Form D) executed by all MBEs and WBEs that the bidder/offeror solicited for participation and (2) Outreach Efforts/Compliance Statement (Form E) that demonstrates the bidder/offeror's good faith efforts to comply with the contract requirements, including copies of solicitation documentation to all potential subcontractors:
2. Emails, letters, facsimile transmittals and confirmations containing plans, specifications, and anticipated time schedule for portions of the work to be performed and meeting notes and agendas clearly identifying the certified MBE or WBE classification and dates that the bidder/offeror contacted each MWBE; and
3. Telephone logs containing names, addresses, dates, telephone numbers, work to be performed, anticipated time schedule and classification of certified MBEs and WBEs contacted.

Bid Rejection: The failure of any bidder/offeror (including the apparent low bidder/offeror) to provide a responsive MWBE Plan as required by the solicitation may result in the bidder/offeror being deemed non-responsive and the County's rejection of the bid.

Liquidated Damages If the County issues a notice of intent to awards contract to the apparent low bidder/offeror who provided a responsive MWBE Plan, but, if after said notice and before execution of Contract Documents, it is determined by the County that the apparent low bidder/offeror has failed to comply with the MWBE Plan, such failure may result in the recommendation by the appropriate Procurement Official to annul the award and forfeit the bidder/offeror's Proposal Guaranty to the County, not as a penalty, but as liquidated damages, it being acknowledged that actual damages will be difficult if not impossible to accurately measure. In addition, the County may proceed as it determines to be in its best interest, including but not limited to, the Notice of Award may be made to the next lowest responsive and responsible bidder/offeror or the work may be re-advertised.

Contract Breach: If, after execution of a County contract, the contractor becomes aware it may or will fail to fulfill the applicable MWBE requirements and/or may or will deviate from the contractor's bid response/contract terms, the contractor shall promptly advise the County of this in writing. Thereafter, the County will determine what action or remedy is appropriate on a case-by-case basis, in the County's sole discretion.

Approval Required for Changes: Any and all changes to the MWBE subcontractors or the type or amount of work to be performed by such subcontractors during the contract term must be mutually agreeable to the County and the contractor and shall be documented via a contract amendment, executed by legally authorized representatives of the County and the contractor.

Cooperation in Reviews: The bidder/offeror will cooperate with the County in any reviews of the contractor's procedures and practices with respect to MBE or WBE firms, which the County may from time to time conduct in its sole discretion.

Other: If the documents used to determine the contractor's efforts, achievement of, and/or the status of an MWBE requirement or fulfillment thereof contain false, misleading or misrepresented information, the contractor may be declared in breach of the contract and the County may take any and all actions and/or remedies available to the County under the contract, at law, or in equity. If an MWBE is disqualified by any public entity, including but not limited to, Baltimore City, the State or MDOT, at any time after award or during the term of the contract, the County may, in its sole discretion, require the prime contractor to promptly submit for County approval, the contractor's plans for fulfilling the required MWBE participation under the contract, and/or request such detail and additional information as the County, in its discretion deems appropriate.



PRIME CONTRACTOR MINORITY AND WOMEN PARTICIPATION AFFIDAVIT

A. AUTHORIZED REPRESENTATIVE

I HEREBY AFFIRM THAT:

I am the [title]_____ and the duly authorized representative of
[business]_____
_____ (the "Business") and that I possess the legal authority to make this
Affidavit on behalf of myself and the Business for which I am acting.

B. AFFIRMATION REGARDING MINORITY AND WOMEN PARTICIPATION

I FURTHER AFFIRM THAT:

I am aware that, pursuant to the December 6, 2022 Executive Order of Baltimore County, Maryland, the following words have the meanings indicated.

(A) "Minority Business Enterprise" or "MBE" means a business enterprise that is owned, operated and controlled by one or more minority group members (African American, Hispanic American, Asian American, or Native American) who have at least 51% ownership and in which the minority group members have operational and managerial control, interest in capital and earnings commensurate with their percentage of ownership.

(B) "Women's Business Enterprise" or "WBE" means a business enterprise that is owned, operated and controlled by one or more women who have at least 51% ownership and in which the women have operational and managerial control, interest in capital and earnings commensurate with their percentage of ownership.

____ The Prime is a MBE ☐ or WBE ☐

☐ Maryland State Department of Transportation (MDOT) # _____

☐ City of Baltimore # _____

☐ Name Other Jurisdiction: _____ # _____

☐ The ownership of the Noncertified MWBE business consists of _____% minorities and _____% women (for a total of _____%), each of which has operational and managerial control, interest in capital and earnings commensurate with their percent ownership.

_____ % African American _____ % Hispanic American _____ % Women
_____ % Asian American _____ % Native American _____ % Disadvantaged (DBE)

____ The MWBE prime anticipates meeting up to 50% of the stated participation goal with its own workforce.

MWBE primes percentage must be stated on the MWBE PRIME PARTICIPATION SCHEDULE (FORM B-PRIME) to count towards the goal.

____ The prime anticipates ☐ does not anticipate ☐ utilizing subcontractors for _____% of the work of the contract requirements, of which it anticipates _____% will be MBEs and _____% will be WBEs.

I DO SOLEMNLY DECLARE AND AFFIRM UNDER THE PENALTIES OF PERJURY THAT THE CONTENTS OF THIS AFFIDAVIT ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE, INFORMATION, AND BELIEF.

Date: _____

By: _____

(Authorized Representative and Affiant's Name and Title)

BALTIMORE COUNTY, MARYLAND
Certified MWBE Utilization and Fair Solicitation Affidavit
(FORM A)

**This document must be completed and submitted with Bid/Proposal to Baltimore County.*

NOTE: If you do not complete and submit this form with your bid or offer to the County, the County may, in its sole discretion, deem your bid or offer NON-RESPONSIVE and accordingly the COUNTY WILL NOT CONSIDER YOU FOR CONTRACT AWARD.

* * * * *

I acknowledge the goal for solicitation # _____ is a minimum of ____%. This goal must be met by any combination of the MWBE subcontractors. However, for instances where the Prime is counting up to 50% of the goal, the remaining goal balance must be met by any combination of the MWBE subcontractors.

- The goal breakdown is as follows:
 - ____% Minority/Women Prime
 - ____% for certified MBE-owned businesses and/or
 - ____% for certified WBE-owned businesses.

I have made a good-faith effort to achieve this MWBE solicitation requirement. If awarded the contract, I will comply with this MWBE contract requirement and will continue to use my best efforts to increase MWBE participation during the contract term.

PLEASE CHECK ONE BOX (EITHER 1, 2, OR 3)

1 ☐ Prime has met the MWBE contract requirements for this solicitation and contract. I submit the Subcontractor Participation Form B and Form C, along with this Affidavit, which details how the Prime will achieve the contract requirements. Submit a complete list of all additional subcontractors

Or

2 ☐ After having made a good-faith effort to achieve the MWBE requirements, the Prime can only achieve partial success. I submit the Subcontractor Participation Form B, Form C, Form D and Form E along with this Affidavit, which details how the Prime will partially achieve the contract requirements. Submit a complete list of all additional subcontractors

I request a partial waiver and will meet the following MWBE participation goals:

- Partial waiver of MWBE subcontract participation:
 - ____% Minority/Women Prime
 - ____% for certified MBE-owned businesses and/or
 - ____% for certified WBE-owned businesses.

Or

3 ☐ After having made a good faith effort to achieve the MWBE requirements for this contract, the Prime is unable to achieve the requirements and/or sub requirements for this contract. I submit the MWBE Participation Form D and Form E, along with this Affidavit, which details the steps the Prime has taken in an attempt to achieve the contract requirements. Therefore, I request a full waiver.

IF YOU HAVE CHECKED BOX 2 OR 3, THE FOLLOWING IS APPLICABLE:

- 1) If a bidder is unable to comply with the goals established in a bid for a project, the bidder may submit a request for a waiver at the time of bid submission. However, occasions for granting waivers will be limited.

BALTIMORE COUNTY, MARYLAND
Certified MWBE Utilization and Fair Solicitation Affidavit
(FORM A)

- 2) The request for waiver shall include documentation that demonstrates the bidder's good faith efforts to comply with the goals, including:
- a. Signed unavailability statements from all MBEs and WBEs that the bidder solicited for participation; and
 - b. Copies of solicitation documentation to include the scope of services to be performed by the subcontractors accompanied with the following:
 - i. Emails, letters, facsimile transmittals and confirmations containing plans, specifications, and anticipated time schedule for portions of the work to be performed and meeting notes and agendas clearly identifying the certified MBE or WBE classification and dates that the bidder contacted each; and
 - ii. Telephone logs containing names, addresses, dates, telephone numbers, work to be performed, anticipated time schedule and classification of certified MBEs and WBEs contacted.
 - iii. Responses from MWBE firms contacted to fulfill the goal.

As I have checked Box 2 or 3 of this Affidavit, I understand I must submit the following supporting documentation with the bid:

- *Subcontractor Participation Schedule* (Form B)
- *MWBE Subcontractor Disclosure and Participation Statement* (Form C)
- *MWBE Subcontractors Unavailable Certificate* (Form D) (if applicable)
- *MWBE Outreach Efforts – Compliance Statement* (Form E) (if applicable)

I acknowledge that the MWBE subcontractors/suppliers listed on the *Subcontractor Participation Schedule* (Form B) will be used to accomplish the percentage of MWBE participation that the Prime shall achieve. A fully executed Form C must match Form B.

In the solicitation of subcontract quotations or offers, MWBE subcontractors were provided the same information and amount of time to respond, as were non-MWBE subcontractors.

The solicitation process was conducted in such a manner so as to not place MWBE subcontractors at a competitive disadvantage to non-MWBE subcontractors.

I solemnly affirm under the penalties of perjury that this Affidavit is true to the best of my knowledge, information, and belief.

Bidder/Offeror Name

Phone Number

Address

Affiant Signature

Address (continued)

Printed Name & Title

E-mail address

Date

**BALTIMORE COUNTY, MARYLAND
SUBCONTRACTOR PARTICIPATION
SCHEDULE (FORM B)**

**This document must be completed and submitted with Bid/Proposal to
Baltimore County.*

NOTE: If you do not complete and submit this form with your bid or offer to the County, the County may, in its sole discretion, deem your bid or offer NON-RESPONSIVE and accordingly the COUNTY WILL NOT CONSIDER YOU FOR CONTRACT AWARD.

Prime Name	Prime Address, Telephone Number and Email						
Bid/Proposal Name and Number	Project Location						
	Base Bid \$ _____						
1. Subcontractor Name and Tax ID	Subcontractor Address						
Telephone Number _____ Email Address _____ Select One: <input type="checkbox"/> MBE <input type="checkbox"/> WBE <input type="checkbox"/> SBE <input type="checkbox"/> N/A Provide if Applicable: <input type="checkbox"/> MDOT <input type="checkbox"/> Baltimore City # _____	Minority Status (If applicable): <table style="width: 100%;"><tr><td><input type="checkbox"/> African American</td><td><input type="checkbox"/> Female</td></tr><tr><td><input type="checkbox"/> Asian American Pacific</td><td><input type="checkbox"/> Native American</td></tr><tr><td><input type="checkbox"/> Asian American Sub-continent</td><td><input type="checkbox"/> Hispanic American</td></tr></table> <input type="checkbox"/> Supplier, Wholesaler and/or Regular Dealer - 60% Rule	<input type="checkbox"/> African American	<input type="checkbox"/> Female	<input type="checkbox"/> Asian American Pacific	<input type="checkbox"/> Native American	<input type="checkbox"/> Asian American Sub-continent	<input type="checkbox"/> Hispanic American
<input type="checkbox"/> African American	<input type="checkbox"/> Female						
<input type="checkbox"/> Asian American Pacific	<input type="checkbox"/> Native American						
<input type="checkbox"/> Asian American Sub-continent	<input type="checkbox"/> Hispanic American						
NAICS Code(s), Work to be Performed and Subcontract Dollar Amount	Percent of Total Contract (See instructions on Page 1 of the MWBE PARTICIPATION SUMMARY for 60% rule) _____ %						
2. Subcontractor Name and Tax ID	Subcontractor Address						
Telephone Number _____ Email Address _____ Select One: MBE <input type="checkbox"/> WBE <input type="checkbox"/> SBE <input type="checkbox"/> N/A <input type="checkbox"/> Provide if Applicable: <input type="checkbox"/> MDOT <input type="checkbox"/> Baltimore City # _____	Minority Status (If applicable): <table style="width: 100%;"><tr><td><input type="checkbox"/> African American</td><td><input type="checkbox"/> Female</td></tr><tr><td><input type="checkbox"/> Asian American Pacific</td><td><input type="checkbox"/> Native American</td></tr><tr><td><input type="checkbox"/> Asian American Sub-continent</td><td><input type="checkbox"/> Hispanic American</td></tr></table> <input type="checkbox"/> Supplier, Wholesaler and/or Regular Dealer - 60% Rule	<input type="checkbox"/> African American	<input type="checkbox"/> Female	<input type="checkbox"/> Asian American Pacific	<input type="checkbox"/> Native American	<input type="checkbox"/> Asian American Sub-continent	<input type="checkbox"/> Hispanic American
<input type="checkbox"/> African American	<input type="checkbox"/> Female						
<input type="checkbox"/> Asian American Pacific	<input type="checkbox"/> Native American						
<input type="checkbox"/> Asian American Sub-continent	<input type="checkbox"/> Hispanic American						
NAICS Code(s), Work to be Performed and Subcontract Dollar Amount	Percent of Total Contract (See instructions on Page 1 of the MWBE PARTICIPATION SUMMARY for 60% rule) _____ %						
3. Subcontractor Name and Tax ID	Subcontractor Address						
Telephone Number _____ Email Address _____ Select One: MBE <input type="checkbox"/> WBE <input type="checkbox"/> SBE <input type="checkbox"/> N/A <input type="checkbox"/> Provide if Applicable: <input type="checkbox"/> MDOT <input type="checkbox"/> Baltimore City # _____	Minority Status (If applicable): <table style="width: 100%;"><tr><td><input type="checkbox"/> African American</td><td><input type="checkbox"/> Female</td></tr><tr><td><input type="checkbox"/> Asian American Pacific</td><td><input type="checkbox"/> Native American</td></tr><tr><td><input type="checkbox"/> Asian American Sub-continent</td><td><input type="checkbox"/> Hispanic American</td></tr></table> <input type="checkbox"/> Supplier, Wholesaler and/or Regular Dealer - 60% Rule	<input type="checkbox"/> African American	<input type="checkbox"/> Female	<input type="checkbox"/> Asian American Pacific	<input type="checkbox"/> Native American	<input type="checkbox"/> Asian American Sub-continent	<input type="checkbox"/> Hispanic American
<input type="checkbox"/> African American	<input type="checkbox"/> Female						
<input type="checkbox"/> Asian American Pacific	<input type="checkbox"/> Native American						
<input type="checkbox"/> Asian American Sub-continent	<input type="checkbox"/> Hispanic American						
NAICS Code(s), Work to be Performed and Subcontract Dollar Amount	Percent of Total Contract (See instructions on Page 1 of the MWBE PARTICIPATION SUMMARY for 60% rule) _____ %						
Subcontractor Total Dollar Amount \$ _____	Total Subcontractor Percent of Entire Contract _____ %						
Form Prepared by: Name/Date: _____ Title: _____ Email: _____	Reviewed and Accepted by Baltimore County Minority Business Enterprise Office Name _____ Title _____ Date _____						

MBE or WBE Prime Participation Total	_____ %	\$ _____	
MBE Subcontracting Participation Total	_____ %	\$ _____	
WBE Subcontracting Participation	_____ %	\$ _____	
Total MWBE Participation	_____ %	\$ _____	
Total SBE Participation	_____ %	\$ _____	

BALTIMORE COUNTY, MARYLAND

**MWBE PRIME PARTICIPATION SCHEDULE
(Form B-Prime)**

PLEASE COMPLETE AND SUBMIT THIS FORM TO ATTEST EACH SPECIFIC ITEM OF WORK THAT YOU AS THE MWBE PRIME FIRM WILL PERFORM USING ITS OWN WORKFORCE PERTAINING TO THE PERCENTAGE STATED ON THE SUBCONTRACTOR PARTICIPATION SCHEDULE (FORM B) FOR PURPOSES OF MEETING THE MWBE PARTICIPATION GOALS.

**This document must be completed and submitted with Bid/Proposal to Baltimore County.*

NOTE: If you do not complete and submit this form with your bid or offer to the County, the County may, in its sole discretion, deem your bid or offer NON-RESPONSIVE and accordingly the COUNTY WILL NOT CONSIDER YOU FOR CONTRACT AWARD.

Provided that _____ (Prime Contractor's Name) with Certification Number _____ is awarded the County contract in conjunction with Solicitation No. _____, such MWBE Prime Contractor intends to count the distinct, clearly defined portion of the work of the contract that the MBE/WBE Prime Contractor performs with its own forces toward fulfilling **up to fifty-percent (50%) of the MWBE participation goal**, at least \$ _____ which equals to _____% of the Total Contract Amount for performing the following products/services for the Contract:

NAICS CODE	WORK ITEM, SPECIFICATION NUMBER, LINE ITEMS OR WORK CATEGORIES (IF APPLICABLE). FOR CONSTRUCTION PROJECTS, GENERAL CONDITIONS MUST BE LISTED SEPARATELY.	DESCRIPTION OF SPECIFIC PRODUCTS AND/OR SERVICES	VALUE OF THE WORK

MWBE PRIME CONTRACTOR

Signature of Representative: _____

Printed Name and Title: _____

Firm's Name: _____

Federal Identification Number: _____

Address: _____

Telephone: _____

Email Address: _____

Certified Yes No No

Certifying Jurisdiction _____

Date: _____

MWBE PRIME CONTRACTOR

Minority Status:

- ☐ African American
- ☐ Hispanic American
- ☐ Women
- ☐ Asian American
- ☐ Native American

Reviewed and Accepted by Baltimore County Minority Business Enterprise Office

Name _____

Title _____

Date _____

BALTIMORE COUNTY, MARYLAND
MWBE SUBCONTRACTOR DISCLOSURE AND PARTICIPATION STATEMENT
(FORM C)

**This document must be completed and submitted with Bid/Proposal to Baltimore County.*

NOTE: If you do not complete and submit this form with your bid or offer to the County, the County may, in its sole discretion, deem your bid or offer NON-RESPONSIVE and accordingly the COUNTY WILL NOT CONSIDER YOU FOR CONTRACT AWARD.

**NOTE: ANY INCONSISTENCY BETWEEN THIS FORM AND FORM B MWBE PARTICIPATION MAY
RENDER A BID/PROPOSAL NON-RESPONSIVE AND THE COUNTY WILL NOT CONSIDER YOU FOR
CONTRACT AWARD.**

Contract Name, Bid/Proposal Number: _____

Prime Contractor Name: _____

Name of MWBE Subcontractor: _____

Subcontractor Contact Name, Title

Subcontractor Email Address

☐ MDOT ☐ Baltimore City

_____ Certification Number

☐ MBE ☐ WBE ☐ SBE ☐ N/A

1. NAICS Code(s), Work/Services to be performed by MWBE Subcontractor: _____

**Percent of Total Contract (See instructions on Page 1 of the MWBE
PARTICIPATION SUMMARY for 60% rule)**

2. Subcontract Amount: \$ _____ or _____ % of the County contract cost.

3. Bonds - Amount and type required of Subcontractor if any: _____

4. MWBE Anticipated Commencement Date: _____ Completion Date: _____
Mobilization Cost Amount \$ _____

5. This is a MBE-Owned Business Firm: Yes _____ No _____

6. This is a WBE-Owned Business Firm: Yes _____ No _____

NOTE: If the Prime is notified that it will be awarded the above referenced contract, the undersigned MWBE subcontractor and Prime must enter into a subcontract for the work/service indicated above upon the Prime's execution of a contract for the above referenced project with Baltimore County, and provide a copy of the fully executed MWBE SUBCONTRACTOR PARTICIPATION NOTICE OF INTENT TO AWARD (FORM C-Subcontractor) accompanied with the anticipated Work Breakdown Schedule (providing the subcontractor's mobilization timeframe) to mwbe@baltimorecountymd.gov within 10 calendar days of receipt by the Prime of FORM C- Subcontractor from the County. The undersigned subcontractor is an MDOT or Baltimore City certified MWBE firm. The terms and conditions stated above are consistent with our agreements.

Signature of MWBE Subcontractor: _____ Date: _____

Prime's Printed Name and Title: _____ Email: _____

The terms and conditions stated above are consistent with our agreements.

Signature of Prime: _____ Date: _____

Revised 12/2024

BALTIMORE COUNTY, MARYLAND
MWBE –UNAVAILABILITY CERTIFICATE
(FORM D)

If applicable, this document must be completed and submitted with Bid/Proposal to Baltimore County.

NOTE: If you do not complete and submit this form with your bid or offer to the County, the County may, in its sole discretion, deem your bid or offer NON-RESPONSIVE and accordingly the COUNTY WILL NOT CONSIDER YOU FOR CONTRACT AWARD.

1. It is hereby certified that the firm of _____
(Name of Minority firm)

located at _____
(Number) (Street)

(City) (State) (Zip)

was offered an opportunity to bid on the _____ contract.

2. The _____ (MWBE Firm), is either unavailable for the work/service or unable to prepare a bid for this project for the following reason(s):

Signature of Subcontractor MWBE Representative

Title

Date

MDOT/Baltimore City Certification #

Email Address #

Telephone #

3. PRIME'S SIGNATURE AND CERTIFICATION

I certify under oath that I contacted the Certified MWBE and they advised me that they are unavailable, unable to perform the work/services for the above-contract or failed to respond to repeated requests for a price proposal for the above-contract.

Signature of Prime

Title

Date

Rev 12/2024

BALTIMORE COUNTY, MARYLAND
MWBE - OUTREACH EFFORTS - COMPLIANCE STATEMENT
(FORM E)

****This document must be completed and submitted with Bid/Proposal to Baltimore County.***

NOTE: If you do not complete and submit this form with your bid or offer to the County, the County may, in its sole discretion, deem your bid or offer NON-RESPONSIVE and accordingly the COUNTY WILL NOT CONSIDER YOU FOR CONTRACT AWARD.

In conjunction with the bid or offer submitted in response to Solicitation Number _____, I state the following:

1. Bidder/Offeror identified opportunities to subcontract in these specific work categories:

2. Attached to this form are copies of the solicitation documentation in accordance with Section 6 (E) Bid Requirements of the Executive Order, used to solicit certified MWBEs for the subcontract opportunities accompanied with the signed MWBE Subcontractor Unavailability Certificate (Form D).

3. Bidder/Offeror made the following attempts to solicit MWBEs:

Signature – Bidder Offeror

Print or Type Name of Firm

Street Address

City State Zip Code

Date



JOHN A. OLSZEWSKI, JR.
County Executive

SEVETRA PEOPLES-BROWN
Executive Director
Chief of Diversity, Equity and Inclusion

To: Contractors/Consultants

From: Minority and Women Business Enterprise Office

Date: December 13, 2024

Subject: Compliance Reporting and Penalties

Baltimore County, Maryland (the "County") requires all Prime Contractors and all Subcontractors to submit payment reports by the 10th of each month through an online MWBE Compliance Portal (PRISM). The Portal can be found under Compliance Reporting for Primes and Subcontractors at www.baltimorecountymd.gov/go/mwbe. In the event you are not able to enter your payments in PRISM, a spreadsheet is attached for your use. Please be sure to list the PO for each invoice/ payment reported and include in your submission any corresponding documentation (e.g. copies of invoices or canceled checks).

The County has found that a number of companies are failing to file reports in a timely manner, which makes it difficult for the County to verify compliance. As a result, the County has determined to assess penalties for non-compliance, effective September 1, 2018, as follows:

- (a) For failure to file timely monthly reports:
 - a. Assessment of a late fee of \$10 per day per task, up to a maximum of \$1,500 per task; and/or
 - b. For multiple violations, termination of the contract for convenience or for default, with the contractor suspended from participating in County contracts for five (5) years.
- (b) For failure to meet MWBE requirements:
 - a. Assessment of a penalty of up to 10% of the contract value; and/or
 - b. Termination of the contract for convenience, with the contractor suspended from participating in County contracts for five (5) years together with assessment of a penalty of up to 10% of the contract value; and/or
 - c. Termination of the contract for default together with assessment of a penalty of 10% of the contract value.

Each action and/or remedy described above is at the sole discretion of the County, and is in addition to any damages which the County may be entitled to under the contract. This short video can be used as guidance on submitting the Prime to Subcontractor Payment Reporting:

http://stage.prismcompliance.com/etc/movies/vendor_contractpayment_tutorial.htm

If after contract expiration, it has been determined the MWBE firms named were not used or were under used, by the contractor and supporting documentation was not provided and approved by the County the contractor may be assessed a penalty of up to 10% of the contract value and/or suspended from participating in County contracts for 5 years.

Questions regarding this correspondence and/or the use of this system can be directed to the MWBE Office at mwbe@baltimorecountymd.gov or call (410) 887-3407.

Attachment: MWBE Payment Report Form
 MWBE Payment Acknowledgement Form

Cc: File

S E C T I O N V

POST AWARD DOCUMENTS

**This Section to be Completed
by Successful Bidder after Award**

C O N T R A C T A G R E E M E N T

THIS CONTRACT AGREEMENT (“Contract”), IS MADE THIS _____ day of _____ 20____, by and between Baltimore County, Maryland, a body corporate and politic (“County”), and _____, (“Contractor”).

WITNESSETH, that the Contractor, for and in consideration of the payment or payments herein specified and agreed to by the County, hereby covenants and agrees to furnish and deliver all the materials and to do and perform all the work, services, and labor in fulfillment of the requirements of Contract Number **24146 PO0** “Project”) in strict conformity with the solicitation, plans, specifications, special provisions, any and all addenda, and the proposal, at the prices named therein, and all of which are collectively the Proposal, and said Proposal is attached hereto and made a part thereof.

The Project shall be done in strict compliance with (i) the Proposal, (ii) the Baltimore County Department of Public Works and Transportation September 2023 “Standard Specifications for Construction and Materials” and “Standard Details for Construction” (iii) and any and all revisions thereto as of the date of advertisement, including but not limited to the General Conditions Building Projects, as applicable, and all of which (i-iii) are made a part hereof and incorporated herein (collectively, the “Specifications”). Contractor understands and agrees it is Contractor’s responsibility and obligation to obtain a copy of the “Specifications” and agrees the Specifications are incorporated herein. Copies are available on the County’s website at www.baltimorecountymd.gov/departments/public-works/standards.

The Project shall be subject to the inspection and approval of the Office of Budget and Finance – Property Management for Baltimore County, or his authorized representative, and in the event any portion thereof shall be rejected by said Director or his representative as defective or unsuitable, then the said portion shall be removed and replaced and be performed anew to the satisfaction and approval of the said Director or his representative at the cost and expense of the Contractor.

THE CONTRACTOR AFFIRMS that it is aware of, and will comply with, the provisions of Sections 14-101 through 14-108 of the Election Law Article of the Annotated Code of Maryland, as the same may be amended from time to time, which require that every person who makes, during any 12-month period, one or more contracts, with one or more Maryland governmental entities involving cumulative consideration, of at least \$200,000.00, to file with the State Board of Elections certain specified information to include disclosure of attributable political contributions in excess of \$500 during defined reporting periods.

THE CONTRACTOR FURTHER COVENANTS AND AGREES that all the Project shall be furnished, performed and delivered, in every respect, to the satisfaction and approval of the Office of Budget and Finance – Property Management, aforesaid, on or before the expiration of **Two Hundred Seventy-Three (273) CALENDAR DAYS** (the “Contract Period”) after written notice has been given by the Director or their authorized representative to begin the work.

IT IS AGREED THAT TIME IS OF THE ESSENCE. In the event the Contractor fails to achieve Final Completion and Final Acceptance of the Contract work within the Contract Period specified herein, plus any extensions thereto agreed to in writing by a legally authorized representative of the County pursuant to the terms of this Contract, then Contractor shall pay the County the sum of **FIFTEEN HUNDRED DOLLARS (\$1500.00)** as Liquidated Damages for each **CALENDAR DAY** after the expiration of the Contract Period, as may be extended by the County, until the Contractor achieves Final Completion and Final Acceptance of the Project.

Contractor’s Initials

Date

Rev. 09/2024

IT IS FURTHER AGREED that:

- (a) These Liquidated Damages are a reasonable estimate of the County's damages solely due to the public's loss of use of the Project during the delay period and is not a penalty.
- (b) It is very difficult, if not impossible, to accurately measure the damages to the County due to the public's loss of use of the Project during the delay period.
- (c) Notwithstanding GP 8.09 of the Baltimore County Standard Specification for Construction, in addition to the damages due to the public's loss of use of the Project during the delay period, the County is likely to incur additional direct costs during the delay period, including but not limited to, costs for construction management, consultants, architectural services, office trailer and supplies, utilities, County employees' time, County vehicles, and such other costs that the County will incur to continue administration of the construction and the Contract during the delay period, all of which will be monitored by the County, and if so required by the County, the Contractor shall pay such actual damages incurred during the delay period. THE PARTIES HERETO UNDERSTAND AND AGREE THAT CONTRACTOR'S OBLIGATION TO PAY THE COUNTY FOR ACTUAL DAMAGES DURING THE DELAY PERIOD SHALL BE IN ADDITION TO THE CONTRACTOR'S OBLIGATION TO PAY THE LIQUIDATED DAMAGES DUE TO THE PUBLIC'S LOSS OF USE OF THE PROJECT.
- (d) The County shall have the right, but not the obligation, to deduct the Liquidated Damages due to the public's loss of use of the Project, and the County's actual costs and costs to continue administration of the construction and the Contract, from any monies due or any monies that may become due to the Contractor.

IT IS DISTINCTLY UNDERSTOOD AND AGREED that no claim for extra work, material or overhead not specifically provided for in the Contract will be allowed by the County, nor shall the Contractor do any work or furnish any materials not covered by this Contract and the Specifications, unless the same is ordered in writing by a legally authorized representative of the Office of Budget and Finance – Property Management in accordance with the terms of the Contract. Any such work or materials which may be done or furnished by the Contractor without any such written order first being given shall be at said Contractor's sole risk, cost and expense and Contractor hereby covenants and agrees that without such written order, Contractor shall make no claim for compensation for work, materials, or overhead so done or furnished.

NOTWITHSTANDING GP 4.06 OF THE BALTIMORE COUNTY STANDARD SPECIFICATIONS FOR CONSTRUCTION, IT IS SPECIFICALLY AGREED that the Contractor shall have no entitlement to damages arising out of delay, disruption, interference or hindrance from any cause whatsoever. However, this provision shall not preclude recovery or damages by the Contractor for hindrances or delays due solely to fraud or gross negligence on the part of the County or its agents.

IT IS FURTHER DISTINCTLY AGREED that the said Contractor shall not assign this Contract, nor any part thereof, nor any right to any of the monies to be paid hereunder, nor shall any part of the work to be done or material furnished under said Contract be sublet without the prior written consent of a legally authorized representative of the Office of Budget and Finance – Property Management in accordance with the terms of this Contract. Further, the acceptance of the final payment by the Contractor shall effectuate a release in full of all claims against County and its officials, employees, representatives, and agents arising out of, or by reason of the Project and this Contract.

The Contractor shall review government issued identification and badge all employees of the Contractor and its subcontractors. The Contractor shall also review all federal forms, including but not limited to I-9's, for compliance as well as copies of all employment eligibility and identity documentation maintained to the extent required by law.

The Bonds, given by the Contractor in a sum equal to the total contract price of the Project in compliance with the terms and provisions of this Contract, are hereby attached and incorporated herein.

IT IS AGREED that in the event that the County is delayed or prevented from timely execution of this Contract, the Contractor releases County and agrees Contractor shall have no action, claim or demand against County therefore.

Contractor's Initials

Date

Rev. 09/2024

THE CONTRACTOR HEREBY FURTHER AGREES to receive the prices set forth in the Proposal incorporated herein as full compensation for the completion of the Project and, in all respects, to complete said Contract to the satisfaction of the County.

THE CONTRACTOR REPRESENTS AND WARRANTS:

- (i) it is duly formed and validly existing under the laws of the State of _____;
- (ii) it is in good standing in the State of Maryland;
- (iii) it has the power and authority to consummate the obligations and responsibilities contemplated hereby, and has taken all necessary action to authorize the execution, delivery and performance required under this Contract;
- (iv) the Contractor and the person executing this Contract for the Contractor each warrant that he/she is duly authorized by the Contractor to execute and seal this Contract on the Contractor's behalf;
- (v) the warranties of merchantability and fitness for a particular purpose and use and warranties of title and against infringement, and all express warranties contained in this Contract, including but not limited to the Proposal (and any sample or model presented by Contractor and expressly accepted by the County) shall apply to the portion of this Contract pertaining to or for goods;
- (vi) all representations and warranties made in the Proposal and herein remain true and correct in all respects when made, as of the date of this Contract, and throughout the term of this Contract; and
- (vii) there exists no actual or potential conflict of interest between its performance under this Contract and its engagement or involvement in any other personal or professional activities and in the event such conflict or potential conflict arises during the term of this Contract, the Contractor shall immediately advise the County in writing thereof.

THE CONTRACTOR shall not disclose any documentation and information of any kind or nature disclosed to the Contractor in the course of its performance of duties hereunder without the express prior written consent of the County.

Those sections in this Contract which by their nature are intended to survive, including but not limited to, Contractor's representations and warranties, confidential information, and indemnification shall survive the termination of this Contract.

IN WITNESS WHEREOF, the Contractor has hereunto set its hand and seal the day and year first above written.

CONTRACTOR NAME: _____

WITNESS FEDERAL TAX ID or SS #: _____

By: _____ (Seal)

Name: _____

Type (Print) Name

Title: _____ Date: _____

WITNESS: **BALTIMORE COUNTY, MARYLAND**

Executive Secretary By: _____ Date: _____
D'Andrea L. Walker, County Administrative Officer

Type (Print) Name

APPROVED FOR FORM AND LEGAL
AND SUFFICIENCY* (Subject to
execution by the duly authorized
Administrative official and Chairperson
of the County Council, as indicated).

APPROVED:

Kevin D. Reed, Director
Office of Budget and Finance Date: _____

Office of the County Attorney

*Approval of Form and Legal Sufficiency does not convey approval or disapproval of the substantive nature of this transaction. Approval is based upon typeset documents. All modifications require re-approval.

PERFORMANCE BOND

Bond No. _____

Principal _____

Business Address of Principal _____

Surety _____

Obligee: **BALTIMORE COUNTY, MARYLAND**
A body corporate and politic

A Corporation of the State of _____ and authorized to do business in Maryland

Penal Sum of Bond (express in words and figures)

North Point Library HVAC Renovation

Contract Name

24146 PO0

Contract Number

DOLLARS

\$

20

Date of Contract

20

Date Bond Executed

KNOW ALL MEN BY THESE PRESENTS, that we, the PRINCIPAL, above-named, and SURETY, above-named, and authorized to do business in the State of Maryland, are held and firmly bound unto the OBLIGEE, above-named, in the penal sum of the amount stated above, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, THE PRINCIPAL entered into a certain contract with the OBLIGEE described and dated as shown above and is required to provide this bond pursuant to Maryland State law and/or County law and the contract.

NOW, THEREFORE, if the aforesaid PRINCIPAL shall well and truly perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the OBLIGEE with or without notice to the SURETY, and during the life of any guaranty required under the contract, and shall also well and truly perform and fulfill all the undertakings covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the SURETY being hereby waived, then, this obligation to be void; otherwise to remain in full force and effect.

THE SURETY FURTHER GUARANTEES That it is (a) licensed in the State of Maryland, (b) rated "B" or better by the A.M. Best Company, (c) on federal funded projects, authorized by the underwriting limitation contained in the U.S. Department of the Treasury Circular 570, as amended, to guaranty the amount of the Bid, and (d) in good standing as determined by the County's Engineer. A Performance Bond is required for each and every Contract in excess of twenty-five thousand (\$25,000). A Performance Bond shall be in the amount equal to at least one hundred (100%) percent of the Contract price. The fully executed Performance Bond shall be delivered by the Bidder to the Department's Division of Construction Contracts Administration no later than the time the Contract is to be executed by the Contractor.

IN WITNESS WHEREOF, the above-bounded parties have executed this instrument under their several seals on the date indicated above, the name and seal of each party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

In Presence of:**Individual Principal**

Witness: _____

as to: _____ (SEAL)

Print Name: _____

Print Name: _____

Attest:**Corporate Principal**

(Name of Corporation)

Witness: _____

By: _____ Affix

Print Name: _____

Print Name: _____ Corporate

Title: _____ Seal

Attest:**Surety**

(Name of Surety)

Business Address: _____

Witness: _____

By: _____ Affix

Print Name: _____

Print Name: _____ Corporate

Title: _____ Seal

Reviewed for Baltimore County Requirements

Office of the County Attorney

PAYMENT BOND

Bond Number _____

Principal _____

Business Address of Principal _____

Surety _____

Obligee: **BALTIMORE COUNTY, MARYLAND**
A body corporate and politic

A Corporation of the State of _____ and authorized to do business in Maryland

DOLLARS \$ _____

Penal Sum of Bond (express in words and figures) _____

North Point Library HVAC Renovation
Contract Name_____ 20 _____
Date of Contract24146 PO0
Contract Number_____ 20 _____
Date Bond Executed

KNOW ALL MEN BY THESE PRESENTS, that we, the PRINCIPAL, above-named, and SURETY, above-named, and authorized to do business in the State of Maryland, are held and firmly bound unto the OBLIGEE, above-named, in the penal sum of the amount stated above, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, THE PRINCIPAL entered into a certain contract with the OBLIGEE described and dated as shown above and is required to provide this bond pursuant to Maryland State law and/or County Law and the contract.

NOW, THEREFORE, the condition of this obligation is such that if the aforesaid PRINCIPAL shall promptly make payments to all persons supplying labor and/or material to the PRINCIPAL and to any subcontractor of the PRINCIPAL in the prosecution of the work provided for in said contract and any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the SURETY being hereby waived, then, this obligation to be void; otherwise to remain in full force and effect.

THE SURETY FURTHER GUARANTEES That it is (a) licensed in the State of Maryland, (b) rated "B" or better by the A.M. Best Company, (c) on federal funded projects, authorized by the underwriting limitation contained in the U.S. Department of the Treasury Circular 570, as amended, to guaranty the amount of the Bid, and (d) in good standing as determined by the County's Engineer. A Payment Bond is required for each and every Contract in excess of twenty-five thousand (\$25,000). A Payment Bond shall be in the amount equal to at least one hundred (100%) percent of the Contract price. The fully executed Payment Bond shall be delivered by the Bidder to the Department's Division of Construction Contracts Administration no later than the time the Contract is to be executed by the Contractor.

IN WITNESS WHEREOF, the above-bounded parties have executed this instrument under their several seals on the date indicated above, the name and seal of each party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

In Presence of: _____

Individual Principal

Witness: _____

as to: _____ (SEAL)

Print Name: _____

Print Name: _____

Attest: _____

Corporate Principal

(Name of Corporation)

Witness: _____

By: _____ Affix

Print Name: _____

Print Name: _____ Corporate

Title: _____ Seal

Attest: _____

Surety

(Name of Surety)

Business Address: _____

Witness: _____

By: _____ Affix

Print Name: _____

Print Name: _____ Corporate

Title: _____ Seal

Reviewed for Baltimore County Requirements

Office of the County Attorney



INSURANCE PROVISIONS

1. GENERAL REQUIREMENTS

- 1.1 Coverages Required:
Unless otherwise required by the specifications or the contract, the Contractor/Vendor shall purchase and maintain the insurance coverage's listed herein.
- 1.2 Certificate of Insurance:
Before starting work on the contract, or prior to the execution of the Contract on those bid, the Contractor/Vendor shall provide Baltimore County, Maryland with verification of insurance coverage evidencing the required coverages.
- 1.3 Baltimore County as Insured:
The coverage required, excluding Workers' Compensation and Employers' Liability and Medical Malpractice Liability/Professional Liability/Errors and Omissions Liability, must include Baltimore County, Maryland and its agents, employees, officers, directors, and appointed and elected officials as an additional insured.
- 1.4 Contractor's/Vendor's Responsibility:
The providing of any insurance herein does not relieve the Contractor/Vendor of any of the responsibilities or obligations the Contractor/Vendor has assumed in the contract or for which the Contractor/Vendor may be liable by law or otherwise.
- 1.5 Failure to Provide Insurance:
Failure to provide and continue in force the required insurance shall be deemed a material breach of the contract. The Contractor/Vendor must maintain the insurance coverages required under the terms and conditions on this Contract while this Contract is in effect including renewal and extension terms.

2. INSURANCE COVERAGES

- 2.1 General Liability Insurance
- 2.1.1 Minimum Limits of Coverage:
Personal Injury Liability and Property Damage Liability
Combined Single Limit - \$500,000 each occurrence.
- 2.1.2 Such insurance shall protect the Contractor/Vendor from claims which may arise out of, or result from, the Contractor's/Vendor's operations under the contract, whether such operations be by the Contractor/Vendor, any subcontractor, anyone directly or indirectly employed by the Contractor/Vendor or Subcontractor, or anyone for whose acts any of the above may be liable.
- 2.1.3 Minimum Coverages to be Included:
(a) Independent Contractor's coverage;
(b) Completed Operations and Products Liability coverage;
(c) Contractual Liability coverage.

- 2.1.4 Damages not to be Excluded:
Such insurance shall contain no exclusions applying to operations by the Contractor/Vendor or any Subcontractor in the performance of the Contract including but not limited to:
(a) Collapse of, or structural injury to, any building or structure;
(b) Damage to underground property; or
(c) Damage arising out of blasting or explosion.

2.2 Automobile Liability Insurance

- 2.2.1 Minimum Limits of Coverage:
Bodily Injury Liability and Property Damage Liability
Combined Single Limit - \$500,000 any one accident.
- 2.2.2 Minimum Coverages to be Included:
Such insurance shall provide coverage for all owned, non-owned and hired automobiles.

2.3 Workers' Compensation and Employers' Liability Insurance

Such insurance must contain statutory coverage, including
Employers' Liability insurance with limits of at least:
Bodily Injury by Accident - \$250,000 each accident
Bodily Injury by Disease - \$500,000 policy limit
Bodily Injury by Disease - \$250,000 each employee

2.4 Valuable Papers and Records Coverage and Electronic Data Processing (Data and Media) Coverage

Minimum Limits of Coverage:
\$100,000 Per Claim and Each Occurrence
\$100,000 in the Aggregate

2.5 Other

Such other insurance in form and amount as may be customary for the type of business being under taken by the Contractor/Vendor.

2.6 Builder's Risk

See Special Provisions page 789 and General Conditions page 34, 35, Article 33.