# SPECIFICATIONS FOR

GREEN ACTIVITIES CENTER PARTIAL RENOVATIONS 120 West Harrison Street Vincennes, Indiana 47591 Project #71GA-22-01

> Vincennes University 1002 North 1st Street Vincennes, Indiana 47591

Andrew W. Young, AIA, LEED AP Director of Architectural Services Vincennes University 1002 North 1st Street Vincennes, Indiana 47591 812.888.4323

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#### SECTION 00100 - INVITATION TO BIDDERS

<u>Plans and Specifications</u>: Notice is hereby given that sealed bids in duplicate for the Green Activities Center – Partial Renovations, Vincennes University, Vincennes, Indiana will be received by the Board of Trustees for the Vincennes University at the Office of the Architectural Services & Facilities, 817 N. Second Street, Vincennes, Indiana, until February 23, 2023, at 2:00 PM. Bids will be opened and publicly read aloud immediately following.

Informalities: The Owner reserves the right to accept or reject any bid or waive any informality or errors in bidding.

<u>Method of Bidding</u>: Contract #1: General Construction; Contract #2: Mechanical Construction; Contract #3: Electrical Construction; Contract #4: Unified Bid

<u>Preparation and Submission of Bids</u>: Bids shall be executed in accordance with the provided bid forms, Certification of Non-Segregated Facilities and with Indiana State Board of Accounts Form 96 (revised 2013), a completed AIA Form G705 must be included stating "none" if there are to be no sub-contractors, and accompanied by a satisfactory bid bond, payable to Vincennes University for not less than 5% of the total bid price. Contractor shall acknowledge all addenda on bid form.

<u>Withdrawal of Bid:</u> Should bidder withdraw his bid within 90 days date of opening without written consent of the Owner, the Owner may declare the bid deposit forfeited as liquidated damages.

<u>Contract Security</u>: Contractor receiving award shall furnish an approved Performance Bond in an amount of at least equal to 110% of the contract price and also a Labor and Material Payment Bond in an amount at least equal to 110% of the contract price or in a penal sum not less than that prescribed by law; as securities for the faithful performance of the contract and for the payment of all persons performing labor and furnishing materials on this project.

<u>Plans and Specifications</u>: Performance of the work shall be in accordance with plans and specifications on file at the following locations:

#### OFFICE OF ARCHITECTURAL SERVICES & FACILITIES

Andrew Young, AIA, LEED AP University Architect and Director Vincennes University 817 N. Second Street Vincennes, IN 47591

#### BUILDERS EXCHANGE OF LOUISVILLE

2300 Meadow Drive Louisville, KY 40218 <u>ENGINEER</u>

Erik Heinz, PE, CPESC Heinz Associates 3252 West 500 North Jasper, Indiana 47546

#### <u>CONSTRUCTCONNECT</u>

3825 Edwards Road, Suite 800 Cincinnati, OH 45209

#### **Obtaining Drawings and Specifications**

Copies of Plans and Specifications may be obtained from MACO-Evansville Blue, 600 Court Street, Evansville, Indiana 47708. (812.464.8108) by accessing our website at <a href="https://www.vuplanroom.com">https://www.vuplanroom.com</a>, using your company's active account information to sign in. If your company is not currently registered, you should do so by clicking "Register for an Account". You will receive an activation email to confirm your registration prior to signing in and ordering plans. Registered account holders may download digital files for a nominal fee.

Prime contract bidders may obtain bidding documents for a deposit of \$200 for each complete set. A separate \$20 check made payable to MACO-Evansville Blue is required for shipping charges. Prime bidders may have two (2) complete sets on a refundable basis if: 1) a responsible bid is received and documents are returned directly to the Office of the Architect in good condition within thirty (30) days of receipt of bids; 2) the prospective bidder notifies the Architect of his/her intention not to bid and returns the bidding documents in good condition at least seven (7) days prior to receipt of bids. Any plan holder not in conformance with Item 1 or 2 noted above will forfeit their plan deposit. Deposits should be made payable to Vincennes University.

THE BOARD OF TRUSTEES FOR THE VINCENNES UNIVERSITY CHAIRMAN: Mr. John A. Stachura TREASURER: Mr. Tim Eaton

#### SECTION 00200 - INFORMATION FOR BIDDERS

The Board of Trustees for the Vincennes University, (hereinafter called the "Owner"), invites bids for the Green Activities Center – Partial Renovations, at Vincennes University, Vincennes, Indiana, on the form attached hereto, all blanks of which must be appropriately filled in. Bids will be received by the Owner at the Office of Architectural Services and Facilities, 817 N. Second Street, Vincennes, Indiana, until 2:00 PM local time, on February 23, 2023, at 2:00 PM, and then at said office publicly opened and read aloud.

The envelopes containing the bids must be sealed, addressed to Dr. Charles R. Johnson, President of Vincennes University, Vincennes, Indiana and designated as Bid for (state project name, project number and classification of work).

The Owner may consider informal any bid not prepared and submitted in accordance with the provisions hereof and may waive any informalities or reject any and all bids. Any bid may be withdrawn prior to the above scheduled time for the opening of bids or authorized postponement thereof. Any bid received after the time and date specified shall not be considered. No bidder may withdraw a bid within 90 days after the actual date of the opening thereof.

#### PREPARATION OF BID

Bids shall be executed in accordance with the provided bid forms, Certification of Non-Segregated Facilities, Indiana State Board of Accounts Form 96, a completed AIA Form G705 must be included stating "none" if there are to be no subcontractors, and accompanied by a satisfactory bid bond, payable to Vincennes University for not less than 5% of the total bid price. Contractor shall acknowledge all addenda on the bid form. All blank spaces for bid prices must be filled in, in ink or typewritten, in both words and figures, and the foregoing Certification must be fully completed and executed when submitted.

#### INDIANA LOCAL PREFERENCE REQUIREMENTS:

It is the responsibility of the bidder to comply with Indiana Local Preference Requirement as set out in Indiana Statutes if they expect to receive the preferential treatment under said statute.

#### SUBCONTRACTS

The bidder is specifically advised that any person, firm or other party to whom it is proposed to award a subcontract under this contract --

Must be acceptable to the Owner and Architect

Must submit Certificate of Non-Segregated Facilities if subcontract is over \$10,000.00. Award will not be given by the Owner unless and until the proposed subcontractor has submitted the Certification.

#### EQUAL OPPORTUNITY

Contractor and Contractor's Subcontractors shall not discriminate against any employee or applicant for employment because of race, religion, color, sex or national origin. Contractor shall take affirmative action to insure that applicants are employed, and that employees are treated during employment without regard to their race, religion, color, sex or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the policies of non-discrimination. Contractor and Contractor's Subcontractors shall, in all solicitation or advertisements for employees placed by them or on their behalf, shall state that all qualified applicants will receive consideration for employment without regard to race, religion, color, sex or national origin.

#### MINORITY, WOMEN'S AND VETERAN'S BUSINESS ENTERPRISES

MBE/WBE/VBE Participation Reporting:

- Vincennes University is committed to diversity and non-discrimination in all aspects of its operations. The intent of this article is to insure that MBE, WBE, and VBE's are included in all aspect of bidding and construction of Vincennes University Projects. This expectation extends to all tiers of contractor utilization. Each Prime contractor should actively solicit and include certified minority-, women- and veteran-owned subcontractors in bid submissions.
- The Minority, Women's and Veteran's Business Enterprise Participation Report (form included in specifications) must be submitted with the bid.
- In order to count toward participation goals, the MBEs, WBEs and/or VBEs must be certified by the State of Indiana.
- Owner retains the discretion to hold payment, and/or to reject future bids submitted by the successful Contractor in the event that Contractor misrepresents either MBE/WBE/VBE participation in this Project, or its efforts to obtain MBE/WBE/VBE participation in this project.

#### MANDATORY TIER II REPORTING REQUIREMENT:

The successful Contractor shall take all necessary and reasonable steps to ensure that MBE/WBE/VBEs
have the maximum opportunity to compete for and perform work on this Contract. MBE/WBE/VBE
utilization in the performance of this Contract must be reported with monthly pay applications.
Compliance with Owner's Mandatory Tier II Reporting Requirement is a pre-condition for approval of
pay applications.

If you have any questions or concerns, please contact our Director of Purchasing and Risk Management at <u>mmorrison@vinu.edu</u>.

#### AFFIRMATIVE ACTION

If the prospective contract is for \$50,000 or more and the successful bidder has fifty or more employees, he is required to develop a written affirmative action program that will be documented and filed in the Purchasing Office at Vincennes University. In order to meet the requirements of the Office of Federal and Contract Compliance Program (OFCCP), the contractor must qualify as a federal contractor and thus send Vincennes University a copy of their EE01 report as prescribed in regulation numbers 41CFR 60-2.13(b), 41CFR 60-250.6(f)(7), and 41CFR 60-741.6(f)(9).

#### E-VERIFY

Any successful bidder will have to comply with statutory requirements found in IC22-5-1.7-1. Each successful bidder must affirm that the bidder does not knowingly employ an unauthorized alien, and any subcontractor that the bidder expects to use must participate in the E-Verify program. The E-verify program can be found online at http://www.uscis.gov/E-verify.

#### **METHOD OF BIDDING**

- Contract 1: General Construction
- Contract 2: Mechanical Construction
- Contract 3: Electrical Construction
- Contract 4: Unified Bid

#### **QUALIFICATION OF BIDDER**

The Owner may make such investigation as he deems necessary to determine the ability of the bidder to perform the work, and the bidder shall furnish to the Owner all such information and data for this purpose that the Owner may request. The Owner reserves the right to reject any bid if the evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligations of the contract and to complete the work contemplated therein.

#### **BID SECURITY**

Each bid must be accompanied by certified check of the bidder, or a bid bond, duly executed by the bidder as principal and having a surety thereon a surety company approved by the Owner, in the amount of 5% of the sum of all base bids offered.

#### LIQUIDATED DAMAGES FOR FAILURE TO ENTER INTO CONTRACT

The successful bidder, upon his failure or refusal to execute and deliver the contract and bonds required within 10 days after he has received notice on the acceptance of his bid, shall forfeit to the Owner, as liquidated damages for such failure or refusal, the security deposited with his bid.

#### TIME FOR COMPLETION AND LIQUIDATED DAMAGES

The successful bidder must agree to commence work on or before a date to be specified in a written "Notice to Proceed" of the Owner and to fully complete the project NO LATER THAN OCTOBER 27, 2023. Bidder must agree also to pay as liquidated damages the sum of \$500 for each consecutive calendar day thereafter as hereinafter provided in the General Conditions. The amount of liquidated damages shall apply to each contractor when separate contracts are awarded.

#### CONDITIONS OF WORK

Each bidder must inform himself fully of the conditions relating to the construction of the project and the employment of the labor thereon. Failure to do so will not relieve a successful bidder of his obligation to furnish all materials and labor necessary to carry out the provisions of his contract. Insofar as possible, the contractor, in carrying out his work, must employ such methods of means as will not cause any interruption of or interference with the work of any other contractor.

#### ADDENDA AND INTERPRETATIONS

No interpretation of the meaning of the plans, specifications and other pre-bid documents will be made to any bidder orally.

Every request for such interpretation should be in writing addressed to Project Architect and to be given consideration must be received at least five days prior to the date fixed for the opening of bids. All addenda so issued shall become a part of the contract documents.

#### SECURITY FOR FAITHFUL PERFORMANCE

Simultaneously with his delivery of the executed contract, the Contractor shall furnish a surety bond or bonds as security for faithful performance of this contract and for the payment of all persons performing labor on the project under this contract, as specified in the General Conditions included herein. The surety on such bond or bonds shall be duly authorized surety company satisfactory to the Owner.

#### SITE INSPECTION AND PRE-BID MEETING

All bidders must inspect the site for existing conditions. Contact Jeff Weber at 812-888-5307 or Jeffrey.weber@vinu.edu for access to the site.

A mandatory pre-bid meeting will be held in the Architectural Services Office at 817 N. Second Street, on February 9, 2023, at 11:00 AM local time. All bidders, both prime contractors and sub-contractors are urged to attend for the purpose of clarifying the meaning and intent of the drawings and specifications.

#### POWER OF ATTORNEY

Attorney-in-fact who sign bid bonds or contract bonds must file with each bond a certified and effectively dated copy of their power of attorney.

#### NOTICE OF SPECIAL CONDITIONS

Attention is particularly called to those parts of the contract documents and specifications which deal with the following:

Equal Opportunity Affirmative Action Non-Segregated Facilities Insurance Requirement

#### LAWS AND REGULATIONS

The Bidder's attention is directed to the fact that all applicable State Laws, Municipal Ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout, and they will be deemed to be included in the contract the same as though herein written out in full.

The successful contractor shall conform to the following regulations as applicable. Any questions, contact the Project Architect's Office.

OSHA Asbestos Regulation 29 CFR 1926.1101 EPA Regulation 40CFR61 subpart M Indiana Regulation 326IAC 14-2-1 and 14-20

#### **METHOD OF AWARD**

The Contract or Contracts shall be awarded to the lowest and best qualified responsible bidder. Consideration will only be given to Alternate Bids listed in the contract documents. Should the lowest and best bid still exceed the amount of fund available, the Owner has the right to negotiate the contract.

#### **OBLIGATIONS OF BIDDER**

At the time of the opening of bids, each bidder will be presumed to have inspected the site and to have read and to be thoroughly familiar with the plans and contract documents (including all addenda). The failure or omission of any bidder to examine any form, instrument or document shall in no way relieve any bidder from any obligation in respect of his bid.

#### NOTICE OF REQUIREMENT FOR CERTIFICATION OF NON-SEGREGATED FACILITIES

Bidders are cautioned as follows: By signing this bid, the bidder will be deemed to have signed and agreed to the provisions of the "Certification of Non-Segregated Facilities" in this solicitation. The Certification provides that the bidder does not maintain or provide for his employee's facilities which are segregated on a basis of race, creed, color, or on a de facto basis. The Certification also provides that he will not maintain such segregated facilities. Failure of a bidder to agree to the "Certification of Non-Segregated Facilities" will render his bid non responsive to the terms of solicitations involving awards of contracts exceeding \$10,000 which is not exempt from the provision of the Equal Opportunity Clause.

#### PERMITS

State building permits shall be secured and paid for by the Owner.

City and County building permits shall be secured and paid for by the Prime Contractor and included in the base bid.

#### SALES TAX

Vincennes University is exempt from sales tax. The successful bidder will be given tax ID's and exemption forms along with their written Notice to Proceed.

State Board of Accounts Form No 96 (Revised 2005)



# **CONTRACTORS BID FOR PUBLIC WORKS**

# PART I (to be completed for all bids. Please type or print)

	Date:
1.	Owner Name: Vincennes University, Vincennes, Indiana
2.	County:
3.	Bidder (Firm):
	Address:
	City/State:
4.	Telephone Number:
5.	Facsimile Number:
6.	Agent of Bidder (if applicable):
7.	Project Number:
8.	Acknowledgement of Addenda:

Pursuant to notices given, the undersigned offers to furnish labor and/or material necessary to complete the construction work for the public works project, Green Activities Center – Partial Renovations, in accordance with plans and specifications prepared by Andrew Young, AIA LEED AP, Vincennes University,, LLC and dated February 2023, for the sum of:

#### CONTRACT #1: GENERAL CONSTRUCTION

(\$	)
(\$	)
(\$	)
(\$	)
	(\$ (\$

The undersigned further agrees to furnish a bond or certified check with this bid for an amount specified in the notice of the letting. Alternate Bids & Unit Prices must be tabulated on the following page. Any addendums attached will be specifically referenced at the applicable page

Alternates				
No.	Amount (Words)	Amount (Numerals)		
1				
2				
3				
4				
5				

	l	Jnit Prices	
No.	Amount (Words)		Amount (Numerals)
1			

If additional units of material included in the contract are needed, the cost of units must be the same as that shown in the original contract if accepted by the Governmental Unit. If the bid is to be awarded on a unit basis, the itemization of the units shall be shown on a separate attachment.

The contractor and his subcontractors, if any, shall not discriminate against or intimidate any employee, or applicant for employment, to be employed in the performance of this contract, with respect to any matter directly or indirectly related to employment because of race, religion, color, sex, national origin or ancestry. Breach of this covenant may be regarded as a material breach of the contract.

# CERTIFICATION OF USE OF UNITED STATES STEEL PRODUCTS (if applicable)

I, the undersigned bidder or agent as a contractor on a public works project, understand my statutory obligation to use steel products made in the United States. I.C. 5-16-8-2. I hereby certify that I and all subcontractors employed by me for this project will use U.S. steel products on this project if awarded. I understand that violations hereunder may result in forfeiture of contractual payments.

#### ACCEPTANCE

The above bid is accepted this	day of	, 2	subject to the following
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\_\_\_\_

conditions:

Contracting Authority Members:

Section 003000 - form No. 96 (Revised 2005)

W:\\_0000 Current Projects\71GA - Green Activities Center\71GA-22-01 - Partial Renovation\Specs\\_Front End Sections\003000\_Bid Form 96 - Rev 2005 -. docx

# PART II

(Complete sections I, II, III, and IV for all state and local public works projects as required by statutes if project is one hundred thousand dollars (\$100,000) or more. (IC 36-1-12-4)

Owner Name:

Bidder (Firm)

Date:

These statements to be submitted under oath by each bidder with and as a part of his bid. Attach additional pages for each section as needed.

\_\_\_\_\_

#### SECTION I EXPERIENCE QUESTIONNAIRE

1. What public works projects has your organization completed for the period of one (1) year prior to the date of the current bid?

Contract Amount	Class of Work	When Completed	Name and Address of Owner

2. What public works projects are now in process of construction by your organization?

Contract Amount	Class of Work	When Completed	Name and Address of Owner

3. Have you ever failed to complete any work awarded to you? \_\_\_\_\_ If so, where and why?

4. List references from private firms for which you have performed work.

#### SECTION II PLAN AND EQUIPMENT QUESTIONNAIRE

- 1. Explain your plan or layout for performing proposed work. (Examples could include a narrative of when you could begin work, completed the project, number of workers, etc. and any other information which you believe would enable the governmental unit to consider your bid.)
- 2. Please list the names and addresses of all subcontractors (i.e. persons or firms outside your own firm who have performed part of the work) that you have used on public works projects during the past five (5) years along with a brief description of the work done by each subcontractor.
- 3. If you intend to sublet any portion of the work, state the name and address of each subcontractor, equipment to be used by the subcontractor, and whether you will require a bond. However, if you are unable to currently provide a listing, please understand a listing must be provided prior to contract approval. Until the completion of the proposed project, you are under a continuing obligation to immediately notify the governmental unit in the event that you subsequently determine that you will use a subcontractor on the proposed project.
- 4. What equipment do you have available to use for the proposed project? Any equipment to be used by subcontractors may also be required to be listed by the governmental unit.
- 5. Have you entered into contracts or received offers for all materials which substantiate the prices used in preparing your proposal? Otherwise, please explain the rationale used which would corroborate the prices listed.

#### SECTION III CONTRACTOR'S FINANCIAL STATEMENT

<u>Attachment of bidder's financial statement is mandatory</u>. Any bid submitted without said financial statement as required by statute shall thereby be rendered invalid. The financial statement provided hereunder to the governing body awarding the contract must be specific enough in detail so that said governing body can make a proper determination of the bidder's capability for completing the project if awarded.

#### SECTION IV CONTRACTOR'S NON - COLLUSION AFFIDAVIT

The undersigned bidder or agent, being duly sworn on oath, says that he has not, nor has any other member, representative, or agent of the firm, company, corporation or partnership represented by him, entered into any combination, collusion or agreement with any person relative to the price to be bid by anyone at such letting nor to prevent any person from bidding nor to include anyone to refrain from bidding, and that this bid is made without reference to any other bid and without any agreement, understanding or combination with any other person in reference to such bidding.

He further says that no person or persons, firms, or corporation has, have or will receive directly or indirectly, any rebate, fee, gift, commission or thing of value on account of such sale.

#### SECTION V OATH AND AFFIRMATION

I hereby affirm under the penalties of perjury that the facts and information contained in the foregoing bid for public works are true and correct to the best of my knowledge and belief.

Dated at	this	day of	,
		(Name of Organization)	
	Ву		
		(Title of Person Signing)	
	ACKNO	OWLEDGEMENT	
STATE OF	)		
COUNTY OF	) SS: )		
Before me, a Notary Public,	personally appeared the a	bove-named	and
that the statements contain	ed in the foregoing docume	nt are true and correct.	
Subscribed and sworn to be	efore me this	day of	,
My Commission Expires:			
County of Residence:			

\*Bidder is required to submit with his Bid a Fully Executed Certificate of Non-Segregated Facilities\*

#### CERTIFICATION OF NON-SEGREGATED FACILITIES\*

The Bidder certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The Bidder certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location under his control where segregated facilities are maintained. The Bidder agrees that a breach of this certification will be a violation of the Equal Opportunity Clause in any contract resulting from acceptance of this bid. As used in this certification, the term "Segregated Facilities" means any waiting rooms, work area, restrooms and washrooms, restaurants and other areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. The Bidder agrees that (except where he has obtained identical certification from proposed subcontractors for specific time periods) he will obtain identical certification from proposed subcontractors prior to the award of subcontract exceeding \$10,000 which are not exempt from the provisions of the Equal Opportunity Clause, and that he will retain such certifications in his files.

Note: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

Date \_\_\_\_\_, 20\_\_\_\_\_

Name of Bidder \_\_\_\_\_

Ву \_\_\_\_\_

Title \_\_\_\_\_

Official Address (Including Zip Code)

.....

\* MUST BE INCLUDED WITHOUT ALTERATION

#### MINORITY, WOMEN'S AND VETERAN'S BUSINESS ENTERPRISE PARTICIPATION REPORT

The Bidder/Firm is expected to submit with its bid/proposal a Minority, Women's and Veteran's Business Enterprise Participation Report. In this Report, the Bidder/Firm must show that there are certified racial minority, woman-owned and/or veteran owned business enterprises participating in the project. Participation may be as a subcontractor or second tier participation with common suppliers. The Bidder/Firm must indicate the name of the MBE/WBE/VBE's with which it will work; the contact name and phone number of the MBE/WBE/VBEs; the service supplied by the MBE/WBE/VBE. Please note: If the Trade is an overhead item for your entire business, please calculate the proportion of the business that will actually apply to the project in question.

Documentation of the Bidder's/Firm's effort to meet the participation goal must also be submitted at bid time; see page 3 of this form.

Contractors will find a listing of MBE/WBE suppliers certified by the State of Indiana at the following website: <u>https://www.in.gov/idoa/mwbe/2743.htm</u>

Vincennes University reserves the right to verify all information included in the Minority, Women's, and Veteran's Business Enterprise Participation Plan for making final determination of the Bidder's/Firm's responsiveness and responsibility.

#### MBE/WBE/VBE PARTICIPATION REPORT

PROJECT #BID/PROPOSAL DUE DATE:						
PROJECT NAME:						
BIDDER/FIRM:						
ADDRESS:						
CITY/STATE/ZIP						
PHONE:						
EMAIL:						
URL:						

#### Vincennes University Green Activities Center – Partial Renovations

MBE, WBE, VBE PARTICIPATION REPORT: (FIRMS USED)

BIDDER/FIRM\_

The following certified minority, women and/or veteran owned firms will be participating in the project, according to the following schedule. Indicate whether each firm is an MBE, WBE, or VBE

FIRM: MBE	WBE	VBE	TRADE	AMOUNT
CONTACT NAME			PHONE	EMAIL

FIRM:	MBE	WBE	VBE	TRADE	AMOUNT
CONTACT	NAME			PHONE	EMAIL

FIRM: MBE	WBE VBE	<u>TRADE</u>	AMOUNT
CONTACT NAME		<u>PHONE</u>	EMAIL

FIRM: MBE	WBE	VBE	<u>TRADE</u>	<u>AMOUNT</u>
CONTACT NAME			PHONE	EMAIL

If additional room is necessary, please attach a separate page.

By my Signature, I certify that the above statements are true and accurate, all as of the date below. I also understand that any changes to this plan must be approved by Vincennes University and documented by Construction Change Directive.

Agent of Bidder

Date

### Vincennes University Green Activities Center – Partial Renovations

MBE, WBE, VBE PARTICIPATION REPORT (FIRMS ENGAGED)

BIDDER/FIRM\_\_\_\_\_\_

Describe below your efforts to obtain minority, women and veteran's business enterprise participation for this project. BE SURE TO ATTACH A COPY OF ALL SOLICIATION EFFORTS, e.g., ads that were published or networking events, etc.

List below the MBE/WBE/VBE contractors you individually contacted to request a quote for this project:

MBE, WBE, VBE firms contacted (company name and commodity)	Method of Contact (i.e., phone, fax, email address, mailing address AND contact name	MBE	WBE	VBE	Quote Received – not low	No response

MBE, WBE, VBE firms contacted (company name and commodity)	Method of Contact (i.e., phone, fax, email address, mailing address AND contact name	MBE	WBE	VBE	Quote Received – not low	No response

MBE, WBE, VBE firms contacted (company name and commodity)	Method of Contact (i.e., phone, fax, email address, mailing address AND contact name	MBE	WBE	VBE	Quote Received – not low	No response

MBE, WBE, VBE firms contacted (company name and commodity)	Method of Contact (i.e., phone, fax, email address, mailing address AND contact name	MBE	WBE	VBE	Quote Received – not low	No response

If extra space is necessary, please attach additional pages.

#### PAGES 1, 2, AND 3 OF THIS DOCUMENT MUST BE SUBMITTED WITH THE BID

# **AIA** Document G705 – 2001

# List of Subcontractors

**PROJECT:** (Name and address) Green Activities Center - Partial Renovations

**TO ARCHITECT:** (Name and address) Andrew Young, AIA LED AP 1002 N. First Street Vincennes, IN 47591

FROM CONTRACTOR: (Name and address)

DATE: February 2023

ARCHITECT'S PROJECT NUMBER: 71GA-22-01

CONTRACTOR'S PROJECT NUMBER:

(List Subcontractors and others proposed to be employed on the above Project as required by the bidding documents.)

Work/Firm Name

Address/Phone

Superintendent

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# $\operatorname{AIA}^{\circ}$ Document A201° – 2007

# General Conditions of the Contract for Construction

#### for the following PROJECT:

(Name and location or address) Green Activities Center - Partial Renovations 120 West Harrison Street Vincennes, IN 47591

#### THE OWNER:

(Name, legal status and address) Vincennes University 1002 N. First Street Vincennes, IN 47591

#### THE ARCHITECT:

(Name, legal status and address) Andrew Young, AIA LEED AP 1002 N. First Street Vincennes, IN 47591

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# ARTICLE 1 GENERAL PROVISIONS § 1.1 BASIC DEFINITIONS

# § 1.1.1 THE CONTRACT DOCUMENTS

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding requirements.

# § 1.1.2 THE CONTRACT

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

# § 1.1.3 THE WORK

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

# § 1.1.4 THE PROJECT

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

# § 1.1.5 THE DRAWINGS

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

# § 1.1.6 THE SPECIFICATIONS

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

# § 1.1.7 INSTRUMENTS OF SERVICE

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

# § 1.1.8 INITIAL DECISION MAKER

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

# § 1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

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

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

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

# § 1.3 CAPITALIZATION

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

# § 1.4 INTERPRETATION

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

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

§ 1.5.1 The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and will retain all common law, statutory and other reserved rights, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and material or equipment suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with this Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

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

# § 1.6 TRANSMISSION OF DATA IN DIGITAL FORM

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

#### ARTICLE 2 OWNER

# § 2.1 GENERAL

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 The Owner shall furnish to the Contractor within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.

# § 2.2 INFORMATION AND SERVICES REQUIRED OF THE OWNER

§ 2.2.1 Prior to commencement of the Work, the Contractor may request in writing that the Owner provide reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. Thereafter, the Contractor may only request such evidence if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) a change in the Work materially changes the Contract Sum; or (3) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due. The Owner shall furnish such evidence as a condition precedent to commencement or continuation of the Work or the

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portion of the Work affected by a material change. After the Owner furnishes the evidence, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.2 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

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

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

§ 2.2.5 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

# § 2.3 OWNER'S RIGHT TO STOP THE WORK

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

# § 2.4 OWNER'S RIGHT TO CARRY OUT THE WORK

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

# ARTICLE 3 CONTRACTOR

### § 3.1 GENERAL

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

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

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

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# § 3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

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

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

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

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

# § 3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

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

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

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

# § 3.4 LABOR AND MATERIALS

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

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

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

### § 3.5 WARRANTY

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

### § 3.6 TAXES

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

# § 3.7 PERMITS, FEES, NOTICES AND COMPLIANCE WITH LAWS

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

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

§ 3.7.3 If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

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

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall

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continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

# § 3.8 ALLOWANCES

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

§ 3.8.2 Unless otherwise provided in the Contract Documents,

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

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

# § 3.9 SUPERINTENDENT

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

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

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

# § 3.10 CONTRACTOR'S CONSTRUCTION SCHEDULES

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall prepare and submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall not exceed time limits current under the Contract Documents, shall be revised at appropriate intervals as required by the conditions of the Work and Project, shall be related to the entire Project to the extent required by the Contract Documents, and shall provide for expeditious and practicable execution of the Work.

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

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

# § 3.11 DOCUMENTS AND SAMPLES AT THE SITE

The Contractor shall maintain at the site for the Owner one copy of the Drawings, Specifications, Addenda, Change Orders and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and one copy of approved Shop Drawings, Product Data, Samples and similar required

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submittals. These shall be available to the Architect and shall be delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

# § 3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

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

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

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

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

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

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

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

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

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

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. The Contractor shall not be required to provide professional services in violation of applicable law. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will specify all performance and design criteria that such services must satisfy. The Contractor shall cause such services or certifications, specifications, certifications, Shop

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Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor all performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review, approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Contractor shall not be responsible for the adequacy of the performance and design criteria specified in the Contract Documents.

### § 3.13 USE OF SITE

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

# § 3.14 CUTTING AND PATCHING

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

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

### § 3.15 CLEANING UP

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

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

### § 3.16 ACCESS TO WORK

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

### § 3.17 ROYALTIES, PATENTS AND COPYRIGHTS

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

### § 3.18 INDEMNIFICATION

§ 3.18.1 To the fullest extent permitted by law the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss or expense is caused in part by a

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party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

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

# ARTICLE 4 ARCHITECT

# § 4.1 GENERAL

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§ 4.1.1 The Owner shall retain an architect lawfully licensed to practice architecture or an entity lawfully practicing architecture in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

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

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

# § 4.2 ADMINISTRATION OF THE CONTRACT

§ 4.2.1 The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

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

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

### § 4.2.4 COMMUNICATIONS FACILITATING CONTRACT ADMINISTRATION

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

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

§ 4.2.6 The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.5.2 and 13.5.3, whether or not such Work is fabricated, installed or completed.

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However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, material and equipment suppliers, their agents or employees, or other persons or entities performing portions of the Work.

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

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

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

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

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

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

§ 4.2.13 The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

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

#### ARTICLE 5 SUBCONTRACTORS

# § 5.1 DEFINITIONS

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

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

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

§ 5.2.1 Unless otherwise stated in the Contract Documents or the bidding requirements, the Contractor, as soon as practicable after award of the Contract, shall furnish in writing to the Owner through the Architect the names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for each principal portion of the Work. The Architect may reply within 14 days to the Contractor in writing stating (1) whether the Owner or the Architect has reasonable objection to any such proposed person or entity or (2) that the Architect requires additional time for review. Failure of the Owner or Architect to reply within the 14-day period shall constitute notice of no reasonable objection.

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

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

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

# § 5.3 SUBCONTRACTUAL RELATIONS

By appropriate agreement, written where legally required for validity, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work, which the Contractor, by these Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontract agreement that may be at variance with the Contract to the respective proposed Sub-subcontract agreement that may be at variance with the Contract Documents.

# § 5.4 CONTINGENT ASSIGNMENT OF SUBCONTRACTS

§ 5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

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

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

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

§ 5.4.3 Upon such assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

#### CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS ARTICLE 6

§ 6.1 OWNER'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS § 6.1.1 The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and to award separate contracts in connection with other portions of the Project or other construction or operations on the site under Conditions of the Contract identical or substantially similar to these including those portions related to insurance and waiver of subrogation. If the Contractor claims that delay or additional cost is involved because of such action by the Owner, the Contractor shall make such Claim as provided in Article 15.

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

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

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

# § 6.2 MUTUAL RESPONSIBILITY

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

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

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

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

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

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# § 6.3 OWNER'S RIGHT TO CLEAN UP

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

#### ARTICLE 7 CHANGES IN THE WORK

# § 7.1 GENERAL

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

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

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

# § 7.2 CHANGE ORDERS

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

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

# § 7.3 CONSTRUCTION CHANGE DIRECTIVES

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

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

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

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

§ 7.3.4 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed in a proposed Change Order or Construction Change Directive so that application of such unit prices to quantities of Work proposed will cause substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

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

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

§ 7.3.7 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the method and the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.7 shall be limited to the following:

- Costs of labor, including social security, old age and unemployment insurance, fringe benefits required .1 by agreement or custom, and workers' compensation insurance;
- .2 Costs of materials, supplies and equipment, including cost of transportation, whether incorporated or consumed:
- .3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others:
- Costs of premiums for all bonds and insurance, permit fees, and sales, use or similar taxes related to the .4 Work; and
- .5 Additional costs of supervision and field office personnel directly attributable to the change.

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

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

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

# § 7.4 MINOR CHANGES IN THE WORK

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

#### ARTICLE 8 TIME

# § 8.1 DEFINITIONS

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

§ 8.1.2 The date of commencement of the Work is the date established in the Agreement.

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

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

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# § 8.2 PROGRESS AND COMPLETION

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

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

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

# § 8.3 DELAYS AND EXTENSIONS OF TIME

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

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

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

### ARTICLE 9 PAYMENTS AND COMPLETION § 9.1 CONTRACT SUM

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

# § 9.2 SCHEDULE OF VALUES

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit to the Architect, before the first Application for Payment, a schedule of values allocating the entire Contract Sum to the various portions of the Work and prepared in such form and supported by such data to substantiate its accuracy as the Architect may require. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment.

# § 9.3 APPLICATIONS FOR PAYMENT

§ 9.3.1 At least ten days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work. Such application shall be notarized, if required, and supported by such data substantiating the Contractor's right to payment as the Owner or Architect may require, such as copies of requisitions from Subcontractors and material suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ 9.3.1.1 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

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

§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon

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compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage and transportation to the site for such materials and equipment stored off the site.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information and belief, be free and clear of liens, claims, security interests or encumbrances in favor of the Contractor, Subcontractors, material suppliers, or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to the Work.

# § 9.4 CERTIFICATES FOR PAYMENT

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

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

# § 9.5 DECISIONS TO WITHHOLD CERTIFICATION

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

defective Work not remedied; .1

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

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

§ 9.5.3 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or material or equipment suppliers to whom the

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Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Architect will reflect such payment on the next Certificate for Payment.

# § 9.6 PROGRESS PAYMENTS

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

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

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

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and material and equipment suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay or to see to the payment of money to a Subcontractor, except as may otherwise be required by law.

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

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

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

# § 9.7 FAILURE OF PAYMENT

If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents the amount certified by the Architect or awarded by binding dispute resolution, then the Contractor may, upon seven additional days' written notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shut-down, delay and start-up, plus interest as provided for in the Contract Documents.

# § 9.8 SUBSTANTIAL COMPLETION

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

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

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§ 9.8.3 Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion, shall establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance, and shall fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in such Certificate. Upon such acceptance and consent of surety, if any, the Owner shall make payment of retainage applying to such Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

### § 9.9 PARTIAL OCCUPANCY OR USE

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

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

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

### § 9.10 FINAL COMPLETION AND FINAL PAYMENT

§ 9.10.1 Upon receipt of the Contractor's written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection and, when the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with terms and conditions of the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect and will not be canceled or allowed to expire until at least 30 days' prior written notice has been given to the Owner, (3) a written statement that the Contractor knows of no substantial reason that the insurance will not be renewable to cover the period required by the Contract

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Documents, (4) consent of surety, if any, to final payment and (5), if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien. If such lien remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging such lien, including all costs and reasonable attorneys' fees.

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

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

- liens, Claims, security interests or encumbrances arising out of the Contract and unsettled; .1
- .2 failure of the Work to comply with the requirements of the Contract Documents; or
- .3 terms of special warranties required by the Contract Documents.

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

#### PROTECTION OF PERSONS AND PROPERTY ARTICLE 10 § 10.1 SAFETY PRECAUTIONS AND PROGRAMS

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

# § 10.2 SAFETY OF PERSONS AND PROPERTY

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

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

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

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

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

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in

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whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3, except damage or loss attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

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

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

### § 10.2.8 INJURY OR DAMAGE TO PERSON OR PROPERTY

If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, written notice of such injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

### § 10.3 HAZARDOUS MATERIALS

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

§ 10.3.2 Upon receipt of the Contractor's written notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of such material or substance or who are to perform the task of removal or safe containment of such material or substance. The Contractor and the Architect will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased in the amount of the Contractor's reasonable additional costs of shut-down, delay and start-up.

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

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

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

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

### § 10.4 EMERGENCIES

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

#### **ARTICLE 11 INSURANCE AND BONDS**

### § 11.1 CONTRACTOR'S LIABILITY INSURANCE

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

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

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

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

§ 11.1.4 The Contractor shall cause the commercial liability coverage required by the Contract Documents to include (1) the Owner, the Architect and the Architect's consultants as additional insureds for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's operations; and (2) the Owner as an additional

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insured for claims caused in whole or in part by the Contractor's negligent acts or omissions during the Contractor's completed operations.

### § 11.2 OWNER'S LIABILITY INSURANCE

The Owner shall be responsible for purchasing and maintaining the Owner's usual liability insurance.

### § 11.3 PROPERTY INSURANCE

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

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

§ 11.3.1.2 If the Owner does not intend to purchase such property insurance required by the Contract and with all of the coverages in the amount described above, the Owner shall so inform the Contractor in writing prior to commencement of the Work. The Contractor may then effect insurance that will protect the interests of the Contractor, Subcontractors and Sub-subcontractors in the Work, and by appropriate Change Order the cost thereof shall be charged to the Owner. If the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain insurance as described above, without so notifying the Contractor in writing, then the Owner shall bear all reasonable costs properly attributable thereto.

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

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

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

### § 11.3.2 BOILER AND MACHINERY INSURANCE

The Owner shall purchase and maintain boiler and machinery insurance required by the Contract Documents or by law, which shall specifically cover such insured objects during installation and until final acceptance by the Owner; this insurance shall include interests of the Owner, Contractor, Subcontractors and Sub-subcontractors in the Work, and the Owner and Contractor shall be named insureds.

### § 11.3.3 LOSS OF USE INSURANCE

The Owner, at the Owner's option, may purchase and maintain such insurance as will insure the Owner against loss of use of the Owner's property due to fire or other hazards, however caused. The Owner waives all rights of action against the Contractor for loss of use of the Owner's property, including consequential losses due to fire or other hazards however caused.

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§ 11.3.4 If the Contractor requests in writing that insurance for risks other than those described herein or other special causes of loss be included in the property insurance policy, the Owner shall, if possible, include such insurance, and the cost thereof shall be charged to the Contractor by appropriate Change Order.

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

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

### § 11.3.7 WAIVERS OF SUBROGATION

The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents and employees, each of the other, and (2) the Architect, Architect's consultants, separate contractors described in Article 6, if any, and any of their subcontractors, sub-subcontractors, agents and employees, for damages caused by fire or other causes of loss to the extent covered by property insurance obtained pursuant to this Section 11.3 or other property insurance applicable to the Work, except such rights as they have to proceeds of such insurance held by the Owner as fiduciary. The Owner or Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors described in Article 6, if any, and the subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged.

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

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

§ 11.3.10 The Owner as fiduciary shall have power to adjust and settle a loss with insurers unless one of the parties in interest shall object in writing within five days after occurrence of loss to the Owner's exercise of this power; if such objection is made, the dispute shall be resolved in the manner selected by the Owner and Contractor as the method of binding dispute resolution in the Agreement. If the Owner and Contractor have selected arbitration as the method of binding dispute resolution, the Owner as fiduciary shall make settlement with insurers or, in the case of a dispute over distribution of insurance proceeds, in accordance with the directions of the arbitrators.

### § 11.4 PERFORMANCE BOND AND PAYMENT BOND

§ 11.4.1 The Owner shall have the right to require the Contractor to furnish bonds covering faithful performance of the Contract and payment of obligations arising thereunder as stipulated in bidding requirements or specifically required in the Contract Documents on the date of execution of the Contract.

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

#### ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

# § 12.1 UNCOVERING OF WORK

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

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

# § 12.2 CORRECTION OF WORK

# § 12.2.1 BEFORE OR AFTER SUBSTANTIAL COMPLETION

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

# § 12.2.2 AFTER SUBSTANTIAL COMPLETION

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of an applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of written notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.4.

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

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

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

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

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be

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sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

### § 12.3 ACCEPTANCE OF NONCONFORMING WORK

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

### ARTICLE 13 MISCELLANEOUS PROVISIONS

### § 13.1 GOVERNING LAW

The Contract shall be governed by the law of the place where the Project is located except that, if the parties have selected arbitration as the method of binding dispute resolution, the Federal Arbitration Act shall govern Section 15.4.

### § 13.2 SUCCESSORS AND ASSIGNS

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

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate such assignment.

### § 13.3 WRITTEN NOTICE

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

### § 13.4 RIGHTS AND REMEDIES

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

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

### § 13.5 TESTS AND INSPECTIONS

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

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

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

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

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

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

### § 13.6 INTEREST

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Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at such rate as the parties may agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

# § 13.7 TIME LIMITS ON CLAIMS

The Owner and Contractor shall commence all claims and causes of action, whether in contract, tort, breach of warranty or otherwise, against the other arising out of or related to the Contract in accordance with the requirements of the final dispute resolution method selected in the Agreement within the time period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all claims and causes of action not commenced in accordance with this Section 13.7.

# ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

# § 14.1 TERMINATION BY THE CONTRACTOR

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, for any of the following reasons:

- .1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- .2 An act of government, such as a declaration of national emergency that requires all Work to be stopped;
  .3 Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or
- .4 The Owner has failed to furnish to the Contractor promptly, upon the Contractor's request, reasonable evidence as required by Section 2.2.1.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor or a Subcontractor, Sub-subcontractor or their agents or employees or any other persons or entities performing portions of the Work under direct or indirect contract with the Contractor, repeated suspensions, delays or interruptions of the entire Work by the Owner as described in Section 14.3 constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' written notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, including reasonable overhead and profit, costs incurred by reason of such termination, and damages.

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

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# § 14.2 TERMINATION BY THE OWNER FOR CAUSE

§ 14.2.1 The Owner may terminate the Contract if the Contractor

- repeatedly refuses or fails to supply enough properly skilled workers or proper materials; .1
- .2 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;
- .3 repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or
- .4 otherwise is guilty of substantial breach of a provision of the Contract Documents.

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

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

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

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

# § 14.3 SUSPENSION BY THE OWNER FOR CONVENIENCE

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

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay or interruption as described in Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

- that performance is, was or would have been so suspended, delayed or interrupted by another cause for .1 which the Contractor is responsible; or
- .2 that an equitable adjustment is made or denied under another provision of the Contract.

# § 14.4 TERMINATION BY THE OWNER FOR CONVENIENCE

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

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

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

§ 14.4.3 In case of such termination for the Owner's convenience, the Contractor shall be entitled to receive payment for Work executed, and costs incurred by reason of such termination, along with reasonable overhead and profit on the Work not executed.

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# ARTICLE 15 CLAIMS AND DISPUTES

# § 15.1 CLAIMS

# § 15.1.1 DEFINITION

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

# § 15.1.2 NOTICE OF CLAIMS

Claims by either the Owner or Contractor must be initiated by written notice to the other party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party must be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

# § 15.1.3 CONTINUING CONTRACT PERFORMANCE

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

# § 15.1.4 CLAIMS FOR ADDITIONAL COST

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

# § 15.1.5 CLAIMS FOR ADDITIONAL TIME

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

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

# § 15.1.6 CLAIMS FOR CONSEQUENTIAL DAMAGES

The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

- .1 damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and
- .2 damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article 14. Nothing contained in this Section 15.1.6 shall be deemed to preclude an award of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

# § 15.2 INITIAL DECISION

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§ 15.2.1 Claims, excluding those arising under Sections 10.3, 10.4, 11.3.9, and 11.3.10, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim arising prior to the date final payment is due, unless 30 days have passed after the Claim has been referred to the Initial Decision Maker with no decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of such request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part.

§ 15.2.5 The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to binding dispute resolution.

§ 15.2.6 Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.

§ 15.2.6.1 Either party may, within 30 days from the date of an initial decision, demand in writing that the other party file for mediation within 60 days of the initial decision. If such a demand is made and the party receiving the demand fails to file for mediation within the time required, then both parties waive their rights to mediate or pursue binding dispute resolution proceedings with respect to the initial decision.

§ 15.2.7 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.8 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

# § 15.3 MEDIATION

§ 15.3.1 Claims, disputes, or other matters in controversy arising out of or related to the Contract except those waived as provided for in Sections 9.10.4, 9.10.5, and 15.1.6 shall be subject to mediation as a condition precedent to binding dispute resolution.

§ 15.3.2 The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of binding dispute resolution proceedings but, in such event, mediation shall proceed in advance of binding dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. If an arbitration is stayed pursuant to this Section 15.3.2, the parties may nonetheless proceed to the selection of the arbitrator(s) and agree upon a schedule for later proceedings.

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§ 15.3.3 The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

### § 15.4 ARBITRATION

**§ 15.4.1** If the parties have selected arbitration as the method for binding dispute resolution in the Agreement, any Claim subject to, but not resolved by, mediation shall be subject to arbitration which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Arbitration Rules in effect on the date of the Agreement. A demand for arbitration shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the arbitration. The party filing a notice of demand for arbitration must assert in the demand all Claims then known to that party on which arbitration is permitted to be demanded.

§ 15.4.1.1 A demand for arbitration shall be made no earlier than concurrently with the filing of a request for mediation, but in no event shall it be made after the date when the institution of legal or equitable proceedings based on the Claim would be barred by the applicable statute of limitations. For statute of limitations purposes, receipt of a written demand for arbitration by the person or entity administering the arbitration shall constitute the institution of legal or equitable proceedings based on the Claim.

§ 15.4.2 The award rendered by the arbitrator or arbitrators shall be final, and judgment may be entered upon it in accordance with applicable law in any court having jurisdiction thereof.

§ 15.4.3 The foregoing agreement to arbitrate and other agreements to arbitrate with an additional person or entity duly consented to by parties to the Agreement shall be specifically enforceable under applicable law in any court having jurisdiction thereof.

### § 15.4.4 CONSOLIDATION OR JOINDER

§ 15.4.4.1 Either party, at its sole discretion, may consolidate an arbitration conducted under this Agreement with any other arbitration to which it is a party provided that (1) the arbitration agreement governing the other arbitration permits consolidation, (2) the arbitrations to be consolidated substantially involve common questions of law or fact, and (3) the arbitrations employ materially similar procedural rules and methods for selecting arbitrator(s).

§ 15.4.4.2 Either party, at its sole discretion, may include by joinder persons or entities substantially involved in a common question of law or fact whose presence is required if complete relief is to be accorded in arbitration, provided that the party sought to be joined consents in writing to such joinder. Consent to arbitration involving an additional person or entity shall not constitute consent to arbitration of any claim, dispute or other matter in question not described in the written consent.

§ 15.4.4.3 The Owner and Contractor grant to any person or entity made a party to an arbitration conducted under this Section 15.4, whether by joinder or consolidation, the same rights of joinder and consolidation as the Owner and Contractor under this Agreement.

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# SUPPLEMENTAL GENERAL CONDITIONS and SPECIAL CONDITIONS

# CONTRACTOR'S AND SUBCONTRACTOR'S PUBLIC LIABILITY, VEHICLE LIABILITY, AND PROPERTY DAMAGE INSURANCE

Commercial General Liability:	
General Aggregate	\$2,000,000
Products & Completed Operations Aggregate	\$2,000,000
Each Occurrence	\$1,000,000
Personal Injury & Advertising Injury	\$1,000,000
Fire Damage Liability	\$ 100,000
Medical Expense	\$ 5,000
Auto Liability:	
Combined Single Limit	\$1,000,000
Any Auto (box should be checked.)	
Workers Compensation	
Coverage A Workers Compensation	Statutory
Coverage B Employers Liability	\$500,000 /\$500,000/ \$500,000
Commercial Umbrella or Excess Liability:	
Each Occurrence	\$5,000,000
Aggregate	\$5,000,000
Installation Floater equal to the amount of the project.	

Additional Remarks Required:

- Vincennes University is named as an additional insured with respects to the General Liability, Auto Liability and Umbrella if required by written contract. Waivers of Subrogation apply in favor of the Additional Insured if required by written contract under the general liability, auto liability, umbrella and workers compensation policies.
- Aggregate per Project Include Waiver of Subrogation for Workers Compensation

# ARBITRATION

Delete Article 15.4.4 in its entirety.

# WAREHOUSE INSURANCE

Should any equipment to be incorporated into the project be stored off-site, the Contractor shall provide proof of insurance to the Owner on said warehouse or storage facility.

# CONNECTION TO OTHER WORK

Where work of the Contractor connects to the work of another trade, this Contractor shall take such precautions as to insure proper connections.

# CONNECTION TO UTILITIES

This Contractor shall verify the Utility Company's policy regarding meter installations, taps, etc., and shall be responsible for making all arrangements and scheduling of work in conjunction with said connections. This Contractor shall, unless otherwise noted, assume all costs arising for this connection.

# Vincennes University Green Activities Center – Partial Renovations

# PREPARATION FOR WORK

The Owner does not in any way agree to prepare the building or site for the reception of the Contractor's work further than is specifically mentioned in the Specifications. The Contractor shall bear full responsibility for the expense of cutting, repairing, excavating, fitting, and patching required if necessary for installing the work on the premises or in the cutting, fitting, and patching required in attaching it to the same, except in circumstances as may be provided in the Contract Documents.

# PROTECTION OF WORK

The Contractor shall assume full responsibility for protection of his work until acceptance by the Owner. He shall also take all precautions to prevent damage to existing equipment, property, or structures which might be caused by him.

In cases where items are damaged, removed, or disturbed by the Contractor, they shall be replaced, repaired, or compensated for in a manner approved by the Architect.

# TEMPORARY SERVICE

Should the Contractor desire to use the project equipment for temporary services, the Owner's approval must be obtained. Should the Owner desire to use equipment prior to acceptance of the project, he may do so but he shall assume all responsibility for its operation.

# STARTING OF EQUIPMENT

All equipment shall be properly aligned and supported and approval obtained for the installation from the manufacturer's representative prior to start-up.

The Architect shall be notified as to scheduled start-up. Qualified personnel shall perform start-up and shall do adjusting that is necessary. Qualified personnel shall supervise the installation for a length of time long enough to determine proper operation of the equipment.

# SAFETY

The Contractor shall be responsible in enforcing safety precautions and shall provide all barricades, signs, lights, and other necessary safeguards.

# **OWNERS INSTRUCTIONS**

The Contractor shall bind one copy of all shop drawings, instructions, and equipment guarantees to be given to the Owner. Said Contractor shall thoroughly instruct and explain the system equipment operation to the Owner.

# CONFLICTS AND DISCREPANCIES

Should any discrepancies, omissions, ambiguities, or conflicts be discovered, they shall be brought to the attention of the Architect for interpretation or clarification. Unless otherwise clarified, the larger quantity and/or better quality material shall be furnished.

# ESSENTIAL ITEMS

Should an item that is essential to the intent of the Contract be omitted from the Plans and Specifications, it shall be called to the Architect's attention. Failure to do so shall not relieve the Contractor from fulfilling the intent of the Contract.

# SUBSTITUTION

Should a substitution of equipment or material be desired by the Contractor, he must submit fully completed form, VU13.1 Substitution Request, and receive prior written approval from the Architect. The Contractor shall be held responsible for the completeness of the equipment, its proper fit in available space, and any change required in other contracts.

# WARRANTIES

Each bidder is hereby notified that upon being awarded a construction contract, the Contractor shall provide to the Owner in writing, a one-year warranty on all materials and labor. The one-year warranty shall begin with the date of established substantial completion.

Any product warranty extending beyond this period shall be honored by the Contractor. Contractor shall provide the labor required to install such products for the duration of the Product warranty.

# PERMITS

State building permits shall be secured and paid for by the Owner. All tap-in fees and specific trade building permits as well as City and County permits are to be included in the bid price.

# FORCE MAJEURE

A party shall not be liable for any failure or delay in performance of this Agreement for the period that such failure or delay is due to causes beyond its reasonable control including acts of God, war, labor strikes, governmental orders, or injunctions. Such party shall give written notice of such force majeure event and take all reasonable steps to mitigate the effect of such force majeure event.



# SUBSTITUTION REQUEST

Project:		Substitution Request Number: Date:	
То:			
A/E Project Number:			
Re:		Contract For:	
Specification Title:		Description:	
Section:	Page:	Article/Paragraph:	
Proposed Substitution:			
Manufacturer:			
Address:		Phone:	
Trade Name:		Model No.:	
Attached data includes product of evaluation of the request; application application of the request; application o	lescription, specific ble portions of the c	ations, drawings, photographs, and performance and test data adequate for lata are clearly identified.	
Attached data also includes a des proper installation.	cription of changes	to the Contract Documents that the proposed substitution will require for its	

### The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substation as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.

Submitted by:	
Signed by:	
Firm:	
Address:	Phone:

### A/E's REVIEW AND ACTION

🗆 Substitution approved – Make submittals in accordance with Specification Section 01 25 00 Substitution Procedures.

Substitution approved as noted - Make submittals in accordance with Specification Section 01 25 00 Substitution Procedures.

□ Substitution rejected – Use specified materials.

 $\hfill\square$  Substitution Request received too late – Use specified materials.

Signed by:

Date:


# **REQUEST FOR INTERPRETATION (RFI)**

Project:		RFI Number:				
		Date:				
From (Contractor):						
То:						
A/E Project Number:						
Re:		Contract For:				
Specification Section:	Paragraph:	Drawing Reference:	Detail:			
Request:						
Signed by:			Date:			
Response:						
□ Attachmonts						
Response From:		То:				
Date Received:		Date Returned:				
Signed by:			Date:			



Project:	Change Order Request Number:
	Date:
From (Contractor):	
То:	
A/E Project Number:	
Re:	Contract For:

Description of Proposed Change:

Reason for Change

Does Proposed Ch Does Proposed Ch	ange involve a change in Contract Sum? No Yes [Increase] [Decrease] ange involve a change in Contract Time? No Yes [Increase] [Decrease]	\$days.
Attached pages:	Proposal Worksheet Other: (Supporting Information from Subcontractor, Supplies, Etc.)	# of Pages
Signed by:		Date:



Project: \_\_\_\_\_ Ch

Change Order Request Number: \_\_\_\_\_

Date: \_\_\_\_\_

-

ADDITIONS		UNIT PRICES		SUBTOTALS			
	Item Description	Quantity	Materials	Labor	Materials	Labor	TOTAL
1							
2							
3							
4							
5							
6							
7							
		Subtotal					

DEDUCTIONS		UNIT PRICES		SUBTOTALS			
	Item Description	Quantity	Materials	Labor	Materials	Labor	TOTAL
1							
2							
3							
4							
5							
6							
7							
		Subtotal					

Add/Deduct TotalContractor's OH&P:Contractor's Bond:Insurance:Tax:WORKSHEET TOTAL	Exempt	
Date:	\$	-

Signed by:

# SECTION 011000 - SUMMARY

PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Project information.
  - 2. Work covered by Contract Documents.
  - 3. Phased construction.
  - 4. Work under separate contracts.
  - 5. Access to site.
  - 6. Coordination with occupants.
  - 7. Work restrictions.
  - 8. Specification and Drawing conventions.

#### 1.2 PROJECT INFORMATION

- A. Project Identification: Vincennes University, Green Activities Center, Partial Renovations. Project #71GA-22-01
  - 1. Project Location: Green Activities Center, Vincennes, Indiana
- B. Owner: Vincennes University
  - 1. Owner's Representative: Andrew Young, AIA, LEED AP

## 1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
  - 1. The removal & replacement of existing HVAC system.
  - 2. The removal & replacement of existing lighting system.
  - 3. The renovation of existing "back of house" areas, to provide for updated green room areas.
  - 4. The removal and replacement f exterior windows
  - 5. Masonry restoration.
- A. The project shall be performed under (3) separate contracts:
  - 1. Contract #1: General Construction.
  - 2. Contract #2: Mechanical Construction.
  - 3. Contract #3: Electrical Construction.
- B. In addition, Owner will entertain bids for Unified contract, which would encompass General, Mechanical, & Electrical Construction:

1. Contract #4: Unified Construction.

# 1.4 ACCESS TO SITE

- A. General: Each Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. Use of Site: Limit use of Project site to Work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
  - 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.
- C. Condition of Existing Buildings: Maintain portions of existing buildings affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.
- D. Cleaning: Perform progress cleaning of work areas affected by its operations on a daily basis. In addition, each Contract shall provide equal resources for weekly cleaning, preferably every Friday afternoon.
- E. Restrooms: Use of Owner's existing restrooms is prohibited. Contractor shall be responsible for providing & servicing their own portable restroom facilities.
- F. Parking/Staging:
  - 1. Owner shall allow parking/staging in paved parking lot in front of building. At Substantial Completion, restore parking/staging areas to condition existing before initial use, including surface, stormwater structures, curbs, etc. Contractors to take special precautions to protect existing pervious pavements.
  - 2. Contractors shall NOT impede any access to adjacent buildings, including D.A.R. building, historical buildings, and Owner's mail facility.

# 1.5 COORDINATION WITH OCCUPANTS

A. Owner Occupancy: Owner will not occupy any portions of the building during construction period.

#### 1.6 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
  - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

- 1. Notify Owner not less than (5) five days in advance of proposed utility interruptions.
- 2. Obtain Owner's written permission before proceeding with utility interruptions.
- C. Restricted Substances: Use of tobacco products and other controlled substances is not permitted.

## 1.7 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
  - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
  - 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
  - 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)

# SECTION 011200 - MULTIPLE CONTRACT SUMMARY

PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes a summary of each contract, including responsibilities for coordination and temporary facilities and controls.
- B. Specific requirements for work of each contract are also indicated in individual Specification Sections and on Drawings.
- C. In the event that a Unified Contract bid is accepted, all work associated with the project & listed below shall be performed by either the Contract-holder, or his qualified & Owner-approved subcontractor.
- D. Related Requirements:
  - 1. Section 011000 "Summary" for the Work covered by the Contract Documents, restrictions on use of Project site, coordination with occupants, and work restrictions.

#### 1.2 DEFINITIONS

A. Permanent Enclosure: As determined by Architect, the condition at which roofing is insulated and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures equivalent in weather protection to permanent construction.

#### 1.3 PROJECT COORDINATOR

A. Project Coordinator (General Construction Contract) shall be responsible for coordination between the General Construction Contract, Mechanical Construction Contract, & Electrical Construction Contract.

#### 1.4 COORDINATION ACTIVITIES

- A. Coordination activities of Project Coordinator include, but are not limited to, the following:
  - 1. Provide overall coordination of the Work.
  - 2. Coordinate shared access to workspaces.
  - 3. Coordinate product selections for compatibility.
  - 4. Provide overall coordination of temporary facilities and controls.
  - 5. Coordinate, schedule, and approve interruptions of permanent and temporary utilities, including those necessary to make connections for temporary services.
  - 6. Coordinate construction and operations of the Work with work performed by each Contract and separate contracts.

- 7. Prepare coordination drawings in collaboration with each contractor to coordinate work by more than one contract.
- 8. Coordinate sequencing and scheduling of the Work including a combined contractors' construction schedule for entire Project.
- 9. Provide photographic documentation.
- 10. Provide quality-assurance and quality-control services specified in Section 014000 "Quality Requirements."
- 11. Coordinate sequence of activities to accommodate tests and inspections, and coordinate schedule of tests and inspections.
- 12. Provide information necessary to adjust, move, or relocate existing utility structures affected by construction.
- 13. Locate existing permanent benchmarks, control points, and similar reference points, and establish permanent benchmarks on Project site.
- 14. Provide field surveys of in-progress construction and site work.
- 15. Provide progress cleaning of common areas and coordinate progress cleaning of areas or pieces of equipment where more than one contractor has worked.
- 16. Coordinate cutting and patching.
- 17. Coordinate protection of the Work.
- 18. Coordinate firestopping.
- 19. Coordinate completion of interrelated punch list items.
- 20. Coordinate preparation of Project record documents if information from more than one contractor is to be integrated with information from other contractors to form one combined record.
- 21. Print and submit record documents if installations by more than one contractor are indicated on the same contract drawing or shop drawing.
- 22. Collect record Specification Sections from contractors, collate Sections into numeric order, and submit complete set.
- 23. Coordinate preparation of operation and maintenance manuals if information from more than one contractor is to be integrated with information from other contractors to form one combined record.
- 24. Provide labor & resources to carefully move/relocate furniture & equipment inside building spaces, to accommodate construction of all (3) contracts. While this is included in Project Coordinator's scope, all contractors & subcontractors are to take special precautions to protect Owner's furniture & equipment. Owner reserves the right to penalize all (3) contracts for any damages incurred.
- B. Responsibilities of Project Coordinator for temporary facilities and controls include, but are not limited to, the following:
  - 1. Provide common-use field office for use by all personnel engaged in construction activities. Owner will allot a defined area inside building, for this common-use field office area.
  - 2. Provide telephone service for common-use facilities. In lieu of building telephone service, individual cellular phones are allowed; Contractor shall provide a listing of their employees & phone numbers to Owner.

## 1.5 GENERAL REQUIREMENTS OF CONTRACTS

- A. Extent of Contract: Unless the Agreement contains a more specific description of the Work of each Contract, requirements indicated on Drawings and in Specification Sections determine which contract includes a specific element of Project.
  - 1. Unless otherwise indicated, the work described in this Section for each contract shall be complete systems and assemblies, including products, components, accessories, and installation required by the Contract Documents.
  - 2. Trenches and other excavation for the work of each contract shall be performed by each Contract.
  - 3. Blocking, backing panels, sleeves, and metal fabrication supports for the work of each contract shall be performed by each Contract.
  - 4. Furnishing of access panels for the work of each contract shall be by each Contract. Installation of access panels shall be the work of the General Construction Contract.
  - 5. Equipment pads for the work of each contract shall be performed by each Contract.
  - 6. Roof-mounted equipment curbs for the work of each contract shall be performed by each Contract. Structural steel reinforcement for roof-mounted equipment for the work of each contract shall be the work of the General Construction Contract.
  - 7. Painting for the work of each Contract shall be by each Contract.
  - 8. Cutting and Patching: Each Contract shall perform its own cutting & patching, using similar materials, and leaving a smooth finish. In addition, surface finish work (i.e, paint, carpet, tile, etc.) shall be by each Contract.
  - 9. Through-penetration firestopping for the work of each contract shall be performed by each Contract.
  - 10. Contractors' Startup Construction Schedule: Within five working days after startup horizontal bar-chart-type construction schedule submittal has been received from Project Coordinator, submit a matching startup horizontal bar-chart schedule showing construction operations sequenced and coordinated with overall construction.
- B. Substitutions: Each contractor shall cooperate with other contractors involved to coordinate approved substitutions with remainder of the work.
  - 1. The Project Coordinator shall coordinate substitutions.
- C. Temporary Facilities and Controls: In addition to specific responsibilities for temporary facilities and controls indicated in this Section and in Section 015000 "Temporary Facilities and Controls," each contractor is responsible for the following:
  - 1. Installation, operation, maintenance, and removal of each temporary facility necessary for its own normal construction activity, and costs and use charges associated with each facility, except as otherwise provided for in this Section.
  - 2. Plug-in electric power cords and extension cords, supplementary plug-in task lighting, and special lighting necessary exclusively for its own activities.
  - 3. Its own field office, complete with necessary furniture, utilities, and telephone service. Owner will allot a defined area inside building, for this common-use field office area.
  - 4. Its own storage and fabrication sheds.
  - 5. Temporary enclosures for its own construction activities.
  - 6. Staging and scaffolding for its own construction activities.
  - 7. General hoisting facilities for its own construction activities, up to 2 tons.

- 8. Waste disposal facilities including collection and legal disposal for its own hazardous, dangerous, unsanitary, or other harmful waste materials. General waste disposal facilities shall be by General Construction Contract.
- 9. Progress cleaning of work areas affected by its operations on a daily basis. In addition, each Contract shall provide equal resources for weekly cleaning, preferably every Friday afternoon.
- 10. Secure lockup of its own tools, materials, and equipment.
- 11. Construction aids and miscellaneous services and facilities necessary exclusively for its own construction activities.
- D. Temporary Heating, Cooling, and Ventilation: The Mechanical Contract is responsible for temporary heating, cooling, and ventilation, including temporary connections.
- E. Use Charges: Comply with the following:
  - 1. Sewer Service: Contractor shall use Owner's existing service. Utility charges paid for by Owner.
  - 2. Water Service: Contractor shall use Owner's existing service. Utility charges paid for by owner.
  - 3. Electric Power Service: Contractor shall use Owner's existing service. Utility charges paid for by Owner.

# 1.6 GENERAL CONSTRUCTION CONTRACT

- A. Work in the General Construction Contract includes, but is not limited to, the following:
  - 1. Roofing, including coverings, flashings, and roof specialties.
  - 2. Interior construction, including partitions, doors, interior glazed openings, and fittings.
  - 3. Plastic laminate casework.
  - 4. Interior finishes and finish carpentry.
  - 5. Miscellaneous items.
  - 6. Structural steel reinforcement for roof-mounted mechanical and electrical equipment.
  - 7. Furnishings, including fixed seating.
  - 8. Any work called out on drawings as work by General Contractor.
  - 9. Full protection of assembly area floors, for full duration of project, including:
    - a. Lobby,
    - b. Auditorium,
    - c. Platform,
    - d. Green Room,
    - e. Dining Room,
    - f. Restrooms,
    - g. Any other similar assembly use areas.
  - 10. Full protection of any carpeted floors, for full duration of project.
  - 11. Final cleaning throughout building.
  - 12. Remaining work not identified as work under other contracts.
  - 13. Video and/or photographic documentation of all pre-project conditions, throughout building.
  - 14. While this list is representational in nature, if any items need clarification or further attention as to which Contract they are part of, please contact the Architect via email. Answers will be sent to all contractors in addendum format.
- B. Temporary facilities and controls in the General Construction Contract include, but are not limited to, the following:

- 1. Temporary facilities and controls that are not otherwise specifically assigned to the other contracts.
- 2. Project identification and temporary signs.
- 3. General waste disposal facilities.
- 4. Pest control.
- 5. Temporary fire-protection facilities.
- 6. Barricades, warning signs, and lights.
- 7. Temporary site access installation and maintenance.
- 8. Erosion/sediment control systems/structures.
- 9. Security enclosure and lockup.
- 10. Environmental protection.
- 11. Restoration of Owner's facilities used as temporary facilities, including damages to parking/staging areas.

## 1.7 MECHANICAL CONTRACT

- A. Work in the Mechanical Contract includes, but is not limited to, the following:
  - 1. Mechanical connections and plumbing to equipment furnished by all other contracts.
  - 2. Domestic water supply and distribution.
  - 3. Sanitary waste.
  - 4. Plumbing fixtures.
  - 5. Domestic water distribution.
  - 6. Stormwater drainage.
  - 7. Special plumbing systems
  - 8. Plumbing connections to equipment.
  - 9. Energy supply, including steam, gas, hot- and chilled-water supply systems.
  - 10. HVAC systems and equipment
  - 11. HVAC instrumentation, controls and building automation system.
  - 12. Variable frequency drives.
  - 13. Interior and exterior mechanical equipment pads.
  - 14. Mechanical Contractor (including plumbing) shall be responsible for, as it pertains to their work, the saw-cutting, excavating, installation, backfilling/compacting, and surface restoration.
  - 15. As they pertain to the Mechanical / Plumbing work, provide and install any roof-mounted equipment curbs & utility curbs.
- B. Temporary facilities and controls in the Mechanical Contract include, but are not limited to, the following:
  - 1. Mechanical & plumbing connections to equipment, systems and temporary controls furnished.

# 1.8 ELECTRICAL CONTRACT

- A. Work in the Electrical Contract includes, but is not limited to, the following:
  - 1. Electrical connections to equipment furnished by all other contracts.
  - 2. Electrical service and distribution.
  - 3. Exterior and interior lighting and light pole bases.
  - 4. Communications and security.

- 5. Special electrical systems, including the following:
  - a. Battery power systems.
- 6. Fire alarm system.
  - a. Electrical Contractor is responsible for removing & re-installing ceiling-mount fire alarm devices to facilitate new ceiling installation, including coring suspended ceiling tiles.
- 7. Interior and exterior electrical equipment pads.
- 8. Electrical Contractor shall be responsible for, as it pertains to their work, the saw-cutting, excavating, installation, & backfilling/compacting, and surface restoration.
- 9. As they pertain to the Electrical work, provide and install any roof-mounted equipment curbs & utility curbs.
- B. Temporary facilities and controls in the Electrical Contract include, but are not limited to, the following:
  - 1. Electrical connections to existing systems and temporary facilities and controls furnished.
  - 2. Electric power service and distribution.
  - 3. Lighting, including site lighting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

# SECTION 012100 - ALLOWANCES

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
  - 1. Contingency allowances.

# 1.2 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Owner and Engineer of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. At Owner's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Owner from the designated supplier.

# 1.3 ACTION SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

## 1.5 COORDINATION

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

## 1.6 CONTINGENCY ALLOWANCES

- A. Contingency allowance shall be included in the base bid, not to any alternates listed.
- B. Use the contingency allowance only as directed by Architect for Owner's purposes and only by written approvals that indicate amounts to be charged to the allowance.
- C. Contractor's related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, insurance, equipment rental, and similar costs.
- D. Approvals authorizing use of funds from the contingency allowance will include Contractor's related costs but not OH&P or bond/insurance margins. Any Contractor mark-up is to be already included in the base bid Contract Sum.
- E. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

## 1.7 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
  - 1. Include installation costs in purchase amount only where indicated as part of the allowance.
  - 2. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
  - 3. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor and installation.
  - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
  - 2. No change to Contractor's indirect expense is permitted for selection of higher- or lowerpriced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

# 3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

## 3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Contract 1 General Contingency Allowance: Include the sum of \$30,000.
- B. Allowance No. 2: Contract 2 -Mechanical Contingency Allowance: Include the sum of \$30,000.
- C. Allowance No. 3: Contract 3 Electrical Contingency Allowance: Include the sum of \$30,000.
- D. Allowance No. 4: Contract 4 Unified Contingency Allowance: Include the sum of \$90,000.
- E. Allowance No. 5: Contract 1 and Contract 4 Hardware Allowance: Include the sum of \$9,000.

# SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Related Requirements:
  - 1. Section 012100 "Allowances" for procedures for using unit prices to adjust quantity allowances.

#### 1.2 DEFINITIONS

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

#### 1.3 PROCEDURES

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

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

# 3.1 SCHEDULE OF UNIT PRICES

A. Unit Price No. 1- Brick Masonry Repointing

## UNIT PRICES

- 1. Description: Brick Masonry Repointing in accordance with Section 040120.64 BRICK MASONRY REPOINTING.
- 2. Unit of Measurement: Cost (\$) per 10 square feet.
- 3. Description: Unit price to include all costs associate with providing brick masonry repointing in addition to what is provided for in the base bid.

# SECTION 012300 - ALTERNATES

PART 1 - GENERAL

## 1.1 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

## 1.2 DEFINITIONS

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

## 1.3 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
  - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

## PART 2 - EXECUTION

## 2.1 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: Window Replacement
  - 1. Base Bid: No work associated with any window removal/replacement.
  - 2. Alternate (Add): Remove/replace all existing windows as indicated on the drawings and in the specifications.
- B. Alternate No. 2: Restroom/Green Room Renovation
  - 1. Base Bid: No work associated with renovation within the partial limit of work lines on the drawings consisting of new Corridor #122, Green Room #123, Restroom #124, Restroom #125, Passage #126, & Staging #127. Mechanical and Electrical work to still be included in the base bid for these areas.
  - 2. Alternate (Add): Provide all work as indicated within the partial limit of work lines on the drawings consisting of new Corridor #122, Green Room #123, Restroom #124, Restroom #125, Passage #126, & Staging #127. Provide for new fire alarm devices & wiring in affected spaces, where shown.
- C. Alternate No. 3: Lift Installation
  - 1. Base Bid: No work associated with providing and installing of new lift in Passage #126 per specifications Section 144216 VERTICAL WHEELCHAIR LIFT. Provide power in the lift location for future use.
  - 2. Alternate (Add): Provide and install new lift in Passage #126 per specifications Section 144216 VERTICAL WHEELCHAIR LIFT.
- D. Alternate No. 4: Masonry Repair
  - 1. Base Bid: No work associated with tuckpointing, repairing, & cleaning of existing exterior face brick.
  - 2. Alternate (Add): Provide for tuckpointing, repairing, & sealing of existing exterior face brick.
- E. Alternate No. 5: Fire Sprinkler Main & System
  - 1. Base Bid: No work associated with new underground water main & interior fire sprinkler system. No work associated with conduit/cabling relocations in riser closet.
  - 2. Alternate (Add): Provide for new underground water main & interior fire sprinkler system, as detailed. Provide for conduit/cabling relocations in riser closet.

# SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

#### 1.1 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.

#### 1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Includes any changes proposed by third-party vendors/suppliers during Bid Phase.

## 1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use VU Form 13.1.
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
    - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
    - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    - e. Samples, where applicable or requested.
    - f. Certificates and qualification data, where applicable or requested.
    - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.

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

## 1.4 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.

## PART 2 - PRODUCTS

## 2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
  - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:
    - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - b. Requested substitution will not adversely affect Contractor's construction schedule.

- c. Requested substitution has received necessary approvals of authorities having jurisdiction.
- d. Requested substitution is compatible with other portions of the Work.
- e. Requested substitution has been coordinated with other portions of the Work.
- f. Requested substitution provides specified warranty.
- g. 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.
  - 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied:
    - 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. Requested substitution will not adversely affect Contractor's construction schedule.
    - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
    - f. Requested substitution is compatible with other portions of the Work.
    - g. Requested substitution has been coordinated with other portions of the Work.
    - h. Requested substitution provides specified warranty.
    - i. 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 3 - EXECUTION (Not Used)

# SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

## 1.1 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

#### 1.2 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.

## 1.3 PROPOSAL REQUESTS

- A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
  - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
  - 2. Within time specified in Proposal Request 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.
- B. Contractor-Initiated Work Change Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
  - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
  - 2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

- 3. Indicate applicable 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.
- C. Use VU Form 13.3, "Change Order Request" form provided by Owner. Sample copy is included in Project Manual. Include necessary background information for pricing on Contractor's in-house forms, with all pricing split between labor, subcontractors, & material.
- D. Owner shall allow a maximum of 10% mark-up for "Contractor's OH&P", and a maximum of 5% mark-up for "Contractor's Bond" & "Insurance" (combined). If Change Order Request is fulfilled through the contract's contingency allowance, then these "Contractor's OH&P", "Contractor's Bond", & "Insurance" values shall be removed, because these same values are already included in the Bidder's overall OH&P mark-up on the base bid project.

# 1.4 ADMINISTRATIVE CHANGE ORDERS

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

## 1.5 CHANGE ORDER PROCEDURES

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

## 1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. 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)

# SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Related Requirements:
  - 1. Section 012100 "Allowances" for procedural requirements governing the handling and processing of allowances.
  - 2. Section 012200 "Unit Prices" for administrative requirements governing the use of unit prices.
  - 3. Section 012600 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
  - 4. Section 013200 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

## 1.2 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
  - 1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
    - a. Application for Payment forms with continuation sheets.
    - b. Submittal schedule.
    - c. Items required to be indicated as separate activities in Contractor's construction schedule.
  - 2. Submit the schedule of values to Architect at earliest possible date but no later than **seven** days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
  - 1. Identification: Include the following Project identification on the schedule of values:
    - a. Project name and location.
    - b. Name of Architect.
    - c. Architect's project number.
    - d. Contractor's name and address.
    - e. Date of submittal.
  - 2. Arrange schedule of values consistent with format of AIA Document G703.

- 3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
- 4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
- 5. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
- 6. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
- 7. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
- 8. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
  - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
- 9. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

## 1.3 RETAINAGE

- A. Payment of the amount certified to be due the Contractor.
  - 1. Ten percent (10%) shall be held as retainage until 50 percent (50%) of the Work is satisfactorily complete, and upon the Owner's discretion, and Architect's recommendation, the retainage may be suspended at that juncture.
  - 2. However, the Ten percent (10%) Contract retainage may be reinstated if completion of the Work and its progress do not remain satisfactory to the Architect or the Owner.

## 1.4 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
  - 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

- 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. Architect will return incomplete applications without action.
  - 1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
  - 2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. Transmittal: Submit two 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.
- F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
  - 1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
  - 2. When an application shows completion of an item, submit conditional final or full waivers.
  - 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
  - 4. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
- 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. Schedule of unit prices.
  - 5. Submittal schedule (preliminary if not final).
  - 6. List of Contractor's staff assignments.
  - 7. List of Contractor's principal consultants.
  - 8. Copies of building permits.
  - 9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
  - 10. Initial progress report.
  - 11. Certificates of insurance and insurance policies.
- 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.
- 2. This application shall reflect Certificates of Partial 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. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
  - 3. Updated final statement, accounting for final changes to the Contract Sum.
  - 4. AIA Document G706-1994, "Contractor's Affidavit of Payment of Debts and Claims."
  - 5. AIA Document G706A-1994, "Contractor's Affidavit of Release of Liens."
  - 6. AIA Document G707-1994, "Consent of Surety to Final Payment."
  - 7. Evidence that claims have been settled.
  - 8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
  - 9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

# SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
  - 1. Coordination drawings.
  - 2. Requests for Information (RFIs).
  - 3. Project meetings.
- B. Related Requirements:
  - 1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

#### 1.2 DEFINITIONS

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

## 1.3 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, and telephone number of entity performing subcontract or supplying products.
  - 2. Number and title of related Specification Section(s) covered by subcontract.
  - 3. Drawing number and detail references, as appropriate, covered by subcontract.

## 1.4 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. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors 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.

## 1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
  - 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
    - a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
    - b. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

## 1.6 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  - 1. Architect will return RFIs submitted to Architect by other entities controlled by Contractor with no response.
  - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  - 1. Project name.
  - 2. Project number.
  - 3. Date.
- 4. Name of Contractor.
- 5. Name of Architect.
- 6. RFI number, numbered sequentially.
- 7. RFI subject.
- 8. Specification Section number and title and related paragraphs, as appropriate.
- 9. Drawing number and detail references, as appropriate.
- 10. Field dimensions and conditions, as appropriate.
- 11. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
- 12. Contractor's signature.
- 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
- C. RFI Forms: Use VU Form 13.2 provided in Project Manual.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow seven working 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 RFIs will be returned without action:
    - a. Requests for approval of submittals.
    - b. Requests for approval of substitutions.
    - c. Requests for coordination information already indicated in the Contract Documents.
    - d. Requests for adjustments in the Contract Time or the Contract Sum.
    - e. Requests for interpretation of Architect's actions on submittals.
    - f. Incomplete RFIs or inaccurately prepared RFIs.
  - 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
  - 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly.
  - 1. Project name.
  - 2. Name and address of Contractor.
  - 3. Name and address of Architect.
  - 4. RFI number including RFIs that were dropped and not submitted.
  - 5. RFI description.
  - 6. Date the RFI was submitted.
  - 7. Date Architect's response was received.
- 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 seven days if Contractor disagrees with response.

# 1.7 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.
  - 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: Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
  - 1. Attendees: Authorized representatives of Owner, 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. Tentative construction schedule.
    - b. Phasing.
    - c. Critical work sequencing and long-lead items.
    - d. Designation of key personnel and their duties.
    - e. Procedures for processing field decisions and Change Orders.
    - f. Procedures for RFIs.
    - g. Procedures for testing and inspecting.
    - h. Procedures for processing Applications for Payment.
    - i. Distribution of the Contract Documents.
    - j. Submittal procedures.
    - k. Preparation of record documents.
    - l. Use of the premises.
    - m. Work restrictions.
    - n. Working hours.
    - o. Owner's occupancy requirements.
    - p. Responsibility for temporary facilities and controls.
    - q. Procedures for moisture and mold control.
    - r. Procedures for disruptions and shutdowns.
    - s. Construction waste management and recycling.
    - t. Parking availability.
    - u. Office, work, and storage areas.
    - v. Equipment deliveries and priorities.
    - w. First aid.
    - x. Security.
    - y. 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 that requires coordination with other construction.
  - 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect 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 problems.
    - k. Time schedules.
    - 1. 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. Progress Meetings: Conduct progress meetings at bi-weekly intervals.
  - 1. 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.

- 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
  - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
    - 1) Review schedule for next period.
  - b. Review present and future needs of each entity present, including the following:
    - 1) Interface requirements.
    - 2) Sequence of operations.
    - 3) Status of submittals.
    - 4) Deliveries.
    - 5) Off-site fabrication.
    - 6) Access.
    - 7) Site utilization.
    - 8) Temporary facilities and controls.
    - 9) Progress cleaning.
    - 10) Quality and work standards.
    - 11) Status of correction of deficient items.
    - 12) Field observations.
    - 13) Status of RFIs.
    - 14) Status of proposal requests.
    - 15) Pending changes.
    - 16) Status of Change Orders.
    - 17) Pending claims and disputes.
    - 18) Documentation of information for payment requests.
- 3. 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)

# SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
  - 1. Contractor's construction schedule.
  - 2. Construction schedule updating reports.
  - 3. Site condition reports.

### 1.2 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. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
  - 1. Working electronic copy of schedule file, where indicated.
  - 2. PDF electronic file.
- B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
  - 1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- C. Construction Schedule Updating Reports: Submit with Applications for Payment.

# 1.4 COORDINATION

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

# PART 2 - PRODUCTS

# 2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

- A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of 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.
- B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
  - 1. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
  - 2. 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.
  - 3. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
  - 4. 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.
  - 5. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.
- C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
  - 1. Phasing: Arrange list of activities on schedule by phase.
  - 2. Work under More Than One Contract: Include a separate activity for each contract.
  - 3. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
  - 4. Work Restrictions: Show the effect of the following items on the schedule:
    - a. Coordination with existing construction.
    - b. Limitations of continued occupancies.
    - c. Uninterruptible services.

- d. Partial occupancy before Substantial Completion.
- e. Use of premises restrictions.
- f. Provisions for future construction.
- g. Seasonal variations.
- h. Environmental control.
- 5. Work Stages: Indicate important stages of construction for each major portion of the Work.
- D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
- E. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
  - 1. Unresolved issues.
  - 2. Unanswered Requests for Information.
  - 3. Rejected or unreturned submittals.
  - 4. Notations on returned submittals.
  - 5. Pending modifications affecting the Work and Contract Time.
- 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.
- G. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

# 2.2 CONTRACTOR'S CONSTRUCTION SCHEDULE (GANTT CHART)

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's construction schedule within 30 days of date established for commencement of the Work.
- 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.

# PART 3 - EXECUTION

# 3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. 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.
- B. 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.

# SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.
- B. Related Requirements:
  - 1. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
  - 2. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
  - 3. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
  - 4. 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.
- 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.

### 1.3 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

# 1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic copies of digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals.
  - 1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and Project record drawings.

- a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
- 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. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Architect 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. Paper Submittals: Place a permanent label or title block on each submittal item for identification.
  - 1. Indicate name of firm or entity that prepared each submittal on label or title block.
  - 2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
  - 3. Include the following information for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name of Architect.
    - d. Name of Construction Manager.
    - e. Name of Contractor.
    - f. Name of subcontractor.
    - g. Name of supplier.
    - h. Name of manufacturer.
    - i. Submittal number or other unique identifier, including revision identifier.
      - 1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A).
    - j. Number and title of appropriate Specification Section.

- k. Drawing number and detail references, as appropriate.
- 1. Location(s) where product is to be installed, as appropriate.
- m. Other necessary identification.
- 4. Additional Paper Copies: Unless additional copies are required for final submittal, and unless Architect observes noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
- 5. Transmittal for Paper Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return without review submittals received from sources other than Contractor.
  - a. Transmittal Form for Paper Submittals: Provide locations on form for the following information:
    - 1) Project name.
    - 2) Date.
    - 3) Destination (To:).
    - 4) Source (From:).
    - 5) Name and address of Architect.
    - 6) Name of Contractor.
    - 7) Name of firm or entity that prepared submittal.
    - 8) Names of subcontractor, manufacturer, and supplier.
    - 9) Category and type of submittal.
    - 10) Submittal purpose and description.
    - 11) Specification Section number and title.
    - 12) Specification paragraph number or drawing designation and generic name for each of multiple items.
    - 13) Drawing number and detail references, as appropriate.
    - 14) Indication of full or partial submittal.
    - 15) Transmittal number.
    - 16) Submittal and transmittal distribution record.
    - 17) Remarks.
    - 18) Signature of transmitter.
- E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
  - 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
  - 2. Name file with submittal number or other unique identifier, including revision identifier.
    - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
  - 3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
  - 4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:

- a. Project name.
- b. Date.
- c. Name and address of Architect.
- d. Name of Contractor.
- e. Name of firm or entity that prepared submittal.
- f. Names of subcontractor, manufacturer, and supplier.
- g. Category and type of submittal.
- h. Submittal purpose and description.
- i. Specification Section number and title.
- j. Specification paragraph number or drawing designation and generic name for each of multiple items.
- k. Drawing number and detail references, as appropriate.
- 1. Location(s) where product is to be installed, as appropriate.
- m. Related physical samples submitted directly.
- n. Indication of full or partial submittal.
- o. Transmittal number.
- p. Submittal and transmittal distribution record.
- q. Other necessary identification.
- r. Remarks.
- F. Options: Identify options requiring selection by Architect.
- G. Deviations: Identify deviations from the Contract Documents on submittals.
- H. 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.
- I. 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.
- J. 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.

# PART 2 - PRODUCTS

### 2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements:
  - 1. Submit electronic submittals via email as PDF electronic files.
    - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

- 2. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect will return two copies.
- 3. Informational Submittals: Submit two paper copies of each submittal unless otherwise indicated. Architect will not return copies.
- 4. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
  - a. Provide a digital signature with digital certificate on electronically-submitted certificates and certifications where indicated.
  - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each submittal to show which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts, hard copies.
    - 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 showing factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  - 5. Submit Product Data before or concurrent with Samples.
  - 6. Submit Product Data in the following format:
    - a. PDF electronic file.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data, unless submittal based on Architect's digital data drawing files is otherwise permitted.
  - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

- a. Identification of products.
- b. Schedules.
- c. Compliance with specified standards.
- d. Notation of coordination requirements.
- e. Notation of dimensions established by field measurement.
- f. Relationship and attachment to adjoining construction clearly indicated.
- g. Seal and signature of professional engineer if specified.
- 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
- 3. Submit Shop Drawings in the following format:
  - a. PDF electronic file.
  - b. Three opaque copies of each submittal. Architect will retain two copies; remainder will be returned.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
  - 1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  - 2. Identification: Attach label on unexposed side of Samples that includes the following:
    - a. Generic description of Sample.
    - b. Product name and name of manufacturer.
    - c. Sample source.
    - d. Number and title of applicable Specification Section.
  - 3. Disposition: Maintain sets of approved Samples at Project site, available for qualitycontrol comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
    - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
  - 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
    - a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
  - 5. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing

color, texture, and pattern; color range sets; and components used for independent testing and inspection.

- a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned.
  - 1) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
  - 1. Submit product schedule in the following format:
    - a. PDF electronic file.
- F. Coordination Drawings Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."
- G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."
- H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures.
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."
- J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."
- K. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
- L. 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.
- M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- N. 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.

- O. 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.
- P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- R. 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.
- S. 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.
- T. 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.
- U. Schedule of Tests and Inspections: Comply with requirements specified in Section 014000 "Quality Requirements."
- V. 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.
- W. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- X. 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.
- Y. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

### PART 3 - EXECUTION

### 3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."
- C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

### 3.2 ARCHITECT'S ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- C. 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.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

# SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

### 1.1 SECTION REQUIREMENTS

- A. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
- B. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements, comply with the most stringent requirement. Refer uncertainties to Architect for a decision.
- C. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum. The actual installation may exceed the minimum within reasonable limits. Indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision.
- D. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
  - 1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.
  - 2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.
- E. 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, and telephone number of testing agency.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Names of individuals making tests and inspections.
  - 6. Description of the Work and test and inspection method.
  - 7. Identification of product and Specification Section.
  - 8. Complete test or inspection data.
  - 9. Test and inspection results and an interpretation of test results.
  - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
  - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  - 12. Name and signature of laboratory inspector.
  - 13. Recommendations on retesting and reinspecting.

- F. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, notices, receipts for fee payments, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.
- G. 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.
- H. Testing Agency Qualifications: An independent agency with the experience and capability to conduct testing and inspecting indicated; and where required by authorities having jurisdiction, that is acceptable to authorities.
- I. 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.
- J. 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 of irregularities or deficiencies in the Work observed during performance of its services.
  - 2. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
  - 3. Do not perform any duties of Contractor.
- K. Associated Services: Cooperate with testing agencies and provide reasonable auxiliary services as requested. Provide the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Security and protection for samples and for testing and inspecting equipment.
- L. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- M. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction.
- N. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

# 3.1 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
- B. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

# SECTION 014200 - REFERENCES

PART 1 - GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- B. Abbreviations and Acronyms: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. (The)
AAADM	American Association of Automatic Door Manufacturers
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABAA	Air Barrier Association of America
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AEIC	Association of Edison Illuminating Companies, Inc. (The)
AF&PA	American Forest & Paper Association
AGA	American Gas Association
AHAM	Association of Home Appliance Manufacturers
AHRI	Air-Conditioning, Heating, and Refrigeration Institute, The
AI	Asphalt Institute
AIA	American Institute of Architects (The)

AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALSC	American Lumber Standard Committee, Incorporated
AMCA	Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
AOSA	Association of Official Seed Analysts, Inc.
APA	Architectural Precast Association
APA	APA - The Engineered Wood Association
API	American Petroleum Institute
ARI	Air-Conditioning & Refrigeration Institute
ARMA	Asphalt Roofing Manufacturers Association
ASCE	American Society of Civil Engineers
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	ASME International (American Society of Mechanical Engineers International)
ASSE	American Society of Sanitary Engineering
ASTM	ASTM International (American Society for Testing and Materials International)
AWCI	Association of the Wall and Ceiling Industry
AWCMA	American Window Covering Manufacturers Association (Now WCMA)
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association (Formerly: American Wood Preservers' Association)
AWS	American Welding Society

AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association (The)
BICSI	BICSI, Inc.
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International)
BISSC	Baking Industry Sanitation Standards Committee
CCC	Carpet Cushion Council
CDA	Copper Development Association
CEA	Canadian Electricity Association
CEA	Consumer Electronics Association
CFFA	Chemical Fabrics & Film Association, Inc.
CGA	Compressed Gas Association
CIMA	Cellulose Insulation Manufacturers Association
CISCA	Ceilings & Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
СРА	Composite Panel Association
СРРА	Corrugated Polyethylene Pipe Association
CRI	Carpet and Rug Institute (The)
CRRC	Cool Roof Rating Council
CRSI	Concrete Reinforcing Steel Institute
CSA	Canadian Standards Association
CSA	CSA International (Formerly: IAS - International Approval Services)
CSI	Cast Stone Institute

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CSI	Construction Specifications Institute (The)
CSSB	Cedar Shake & Shingle Bureau
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute)
DHI	Door and Hardware Institute
EIA	Electronic Industries Alliance
EIMA	EIFS Industry Members Association
EJCDC	Engineers Joint Contract Documents Committee
EJMA	Expansion Joint Manufacturers Association, Inc.
ESD	ESD Association (Electrostatic Discharge Association)
ETL SEMCO	Intertek ETL SEMCO (Formerly: ITS - Intertek Testing Service NA)
FM Approvals	FM Approvals LLC
FM Global	FM Global (Formerly: FMG - FM Global)
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.
FSA	Fluid Sealing Association
FSC	Forest Stewardship Council
GA	Gypsum Association
GANA	Glass Association of North America
GRI	(Part of GSI)
GS	Green Seal
GSI	Geosynthetic Institute
HI	Hydronics Institute
HI/GAMA	Hydronics Institute/Gas Appliance Manufacturers Association Division of Air-Conditioning, Heating, and Refrigeration Institute (AHRI)
НММА	Hollow Metal Manufacturers Association (Part of NAAMM)

HPVA	Hardwood Plywood & Veneer Association
IAPSC	International Association of Professional Security Consultants
ICBO	International Conference of Building Officials
ICEA	Insulated Cable Engineers Association, Inc.
ICPA	International Cast Polymer Association
ICRI	International Concrete Repair Institute, Inc.
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The)
IESNA	Illuminating Engineering Society of North America
IEST	Institute of Environmental Sciences and Technology
IGMA	Insulating Glass Manufacturers Alliance
ILI	Indiana Limestone Institute of America, Inc.
ISA	Instrumentation, Systems, and Automation Society, The
ISO	International Organization for Standardization Available from ANSI
ISSFA	International Solid Surface Fabricators Association
ITS	Intertek Testing Service NA (Now ETL SEMCO)
ITU	International Telecommunication Union
КСМА	Kitchen Cabinet Manufacturers Association
LGSEA	Light Gauge Steel Engineers Association
LPI	Lightning Protection Institute
MBMA	Metal Building Manufacturers Association
MCA	Metal Construction Association
MFMA	Maple Flooring Manufacturers Association, Inc.
MFMA	Metal Framing Manufacturers Association, Inc.

MH	Material Handling (Now MHIA)
MHIA	Material Handling Industry of America
MIA	Marble Institute of America
MPI	Master Painters Institute
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International (National Association of Corrosion Engineers International)
NADCA	National Air Duct Cleaners Association
NAGWS	National Association for Girls and Women in Sport
NAIMA	North American Insulation Manufacturers Association
NBGQA	National Building Granite Quarries Association, Inc.
NCMA	National Concrete Masonry Association
NCTA	National Cable & Telecommunications Association
NEBB	National Environmental Balancing Bureau
NECA	National Electrical Contractors Association
NeLMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFPA	NFPA (National Fire Protection Association)
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NLGA	National Lumber Grades Authority
NOFMA	NOFMA: The Wood Flooring Manufacturers Association (Formerly: National Oak Flooring Manufacturers Association)

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NOMMA	National Ornamental & Miscellaneous Metals Association
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	NSF International (National Sanitation Foundation International)
NSSGA	National Stone, Sand & Gravel Association
NTMA	National Terrazzo & Mosaic Association, Inc. (The)
PCI	Precast/Prestressed Concrete Institute
PDI	Plumbing & Drainage Institute
PGI	PVC Geomembrane Institute
PTI	Post-Tensioning Institute
RCSC	Research Council on Structural Connections
RFCI	Resilient Floor Covering Institute
RIS	Redwood Inspection Service
SAE	SAE International
SCAQMD	South Coast Air Quality Management District
SCTE	Society of Cable Telecommunications Engineers
SDI	Steel Deck Institute
SDI	Steel Door Institute
SEFA	Scientific Equipment and Furniture Association
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)
SIA	Security Industry Association
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association

SMPTE	Society of Motion Picture and Television Engineers
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division)
SPIB	Southern Pine Inspection Bureau (The)
SPRI	Single Ply Roofing Industry
SSINA	Specialty Steel Industry of North America
SSPC	SSPC: The Society for Protective Coatings
STI	Steel Tank Institute
SWI	Steel Window Institute
TCNA	Tile Council of North America, Inc.
TEMA	Tubular Exchanger Manufacturers Association
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
TMS	The Masonry Society
TPI	Truss Plate Institute, Inc.
TPI	Turfgrass Producers International
TRI	Tile Roofing Institute
UL	Underwriters Laboratories Inc.
UNI	Uni-Bell PVC Pipe Association
USGBC	U.S. Green Building Council
USITT	United States Institute for Theatre Technology, Inc.
WASTEC	Waste Equipment Technology Association
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association)
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California)

WIC	Woodwork Institute of California (Now WI)
WMMPA	Wood Moulding & Millwork Producers Association
WSRCA	Western States Roofing Contractors Association
WWPA	Western Wood Products Association

- C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.
- IAPMO International Association of Plumbing and Mechanical Officials
- ICC International Code Council
- ICC-ES ICC Evaluation Service, Inc.
- IAPMO International Association of Plumbing and Mechanical Officials
- ICC International Code Council
- ICC-ES ICC Evaluation Service, Inc.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

# SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

# PART 1 - GENERAL

### 1.1 SECTION REQUIREMENTS

- A. Use Charges: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated.
- B. Water and Electric Power: Available from Owner's existing system without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- C. Erosion- and Sedimentation-Control Plan: Submit plan showing compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- D. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- E. Accessible Temporary Egress: Comply with applicable provisions in ICC A117.1.
- F. Each Contract shall be responsible for installation & removal of electric & telecommunications service to its own field offices and/or job trailers.

# PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts and top and bottom rails.

### 2.2 TEMPORARY FACILITIES

A. Provide field offices, storage and fabrication sheds, and other support facilities as necessary for construction operations. Store combustible materials apart from building.

# 2.3 EQUIPMENT

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

# PART 3 - EXECUTION

# 3.1 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
  - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sanitary Facilities: Use of Owner's existing toilet facilities is allowed. Contractor shall be responsible to clean toilet facilities, as necessary. Owner reserves the right to prohibit toilet facility use, if cleanliness is not maintained.
- C. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

### 3.2 SUPPORT FACILITIES INSTALLATION

- A. Install project identification and other signs in locations approved by Owner to inform the public and persons seeking entrance to Project.
- B. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.
- C. Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

### 3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. 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.
- B. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- C. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- D. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

- E. Furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
- F. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- G. Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
- H. Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
- I. Install and maintain temporary fire-protection facilities. Comply with NFPA 241.

# 3.4 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. 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.
- C. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period.
# SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

#### 1.1 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 012500 "Substitution Procedures" for requests for substitutions.

## 1.2 DEFINITIONS

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

## 1.3 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable

product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- a. Form of Approval: As specified in Section 013300 "Submittal Procedures."
- b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

### 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.

### 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

## 1.6 **PRODUCT WARRANTIES**

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
  - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
  - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
  - 3. Refer to 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 not in conflict with requirements of the Contract Documents.
  - 4. Where products are accompanied by the term "as selected," Architect will make selection.
  - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
  - 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

- 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
- 3. Products:
  - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
  - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
- 4. Manufacturers:
  - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
  - b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
- 5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
  - 1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

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

PART 3 - EXECUTION (Not Used)

## 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. Field engineering and surveying.
  - 3. Installation of the Work.
  - 4. Cutting and patching.
  - 5. Coordination of Owner-installed products.
  - 6. Progress cleaning.
  - 7. Starting and adjusting.
  - 8. Protection of installed construction.
- B. Related Requirements:
  - 1. Section 011000 "Summary" for limits on use of Project site.
  - 2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

## 1.2 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, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural element 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.

## PART 2 - PRODUCTS

#### 2.1 MATERIALS

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

### PART 3 - EXECUTION

### 3.1 EXAMINATION

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

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

## 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 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 the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
  - 2. Establish limits on use of Project site.
  - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 4. Inform installers of lines and levels to which they must comply.
  - 5. Check the location, level and plumb, of every major element as the Work progresses.
  - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
  - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and

electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

## 3.4 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
- B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
  - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
- C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- D. Final Property Survey: Contract #2 to engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
  - 1. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

# 3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- 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 the best possible results. Maintain conditions required for product performance until Substantial Completion.

- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful 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 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.
  - 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. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### 3.6 CUTTING AND PATCHING

- A. Contractor shall be responsible to notify all authorities having jurisdiction, including City, emergency services, schools, etc., for planned street closures. Contractor shall provide for all Maintenance of Traffic requirements, including signage & flaggers.
- B. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- C. 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.
- D. Temporary Support: Provide temporary support of work to be cut.

- E. 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.
- F. Adjacent Occupied Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- G. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- H. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
  - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  - 6. Proceed with patching after construction operations requiring cutting are complete.
- I. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
  - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
  - 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
  - 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
  - 4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
  - 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- J. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

#### 3.7 PROGRESS CLEANING

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

# 3.8 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

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

## 3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

## 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. Warranties.
  - 4. Final cleaning.
  - 5. Repair of the Work.
- B. Related Requirements:
  - 1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
  - 2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
  - 3. Section 017900 "Demonstration and Training" for requirements for instructing Owner's personnel.

## 1.2 ACTION SUBMITTALS

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

#### 1.3 CLOSEOUT SUBMITTALS

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

# 1.4 MAINTENANCE MATERIAL SUBMITTALS

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

## 1.5 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, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
  - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number where applicable.
    - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's signature for receipt of submittals.
  - 5. Submit test/adjust/balance records.
  - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
  - 1. Advise Owner of pending insurance changeover requirements.
  - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
  - 3. Complete startup and testing of systems and equipment.
  - 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
  - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
  - 6. Advise Owner of changeover in heat and other utilities.
  - 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
  - 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
  - 9. Complete final cleaning requirements, including touchup painting.

- 10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 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. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
  - 2. Results of completed inspection will form the basis of requirements for final completion.

# 1.6 FINAL COMPLETION PROCEDURES

- A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
  - 1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
  - 2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
  - 3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  - 4. Submit pest-control final inspection report and warranty.
  - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings.
- B. Inspection: Submit a written request for final inspection to determine acceptance. 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. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

# 1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
  - 1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.

- 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
- 3. Submit list of incomplete items in the following format:
  - a. PDF electronic file. Architect will return annotated copy.

## 1.8 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  - 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.
  - 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

#### 2.1 MATERIALS

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

#### PART 3 - EXECUTION

#### 3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - h. Sweep concrete floors broom clean in unoccupied spaces.
    - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
    - k. Remove labels that are not permanent.
    - 1. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
    - m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
    - n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
    - o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
    - p. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

## 3.2 HVAC FILTERS

A. Replace temporary filters used in HVAC equipment during construction, with all new permanent filters.

B. Provide for (1) set of replacement filters for each piece of HVAC equipment. Coordinate with Owner's Physical Plant.

# 3.3 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
  - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
  - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
  - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

# SECTION 017823 - OPERATION AND MAINTENANCE DATA

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory.
  - 2. Emergency manuals.
  - 3. Operation manuals for systems, subsystems, and equipment.
  - 4. Product maintenance manuals.
  - 5. Systems and equipment maintenance manuals.

## 1.2 CLOSEOUT SUBMITTALS

- A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
  - 1. Architect will comment on whether content of operations and maintenance submittals are acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operations and maintenance manuals in the following format:
  - 1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
    - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
    - b. Enable inserted reviewer comments on draft submittals.
  - 2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Architect, will return two copies.
- C. 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 and Commissioning Authority's comments and prior to commencing demonstration and training.

## PART 2 - PRODUCTS

# 2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information.
- B. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
  - 1. Title page.
  - 2. Table of contents.
  - 3. Manual contents.
- C. 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 Architect.
  - 7. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
  - 8. Cross-reference to related systems in other operation and maintenance manuals.
- D. 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.
- E. 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.
- F. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
  - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
  - 2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

- G. 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 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. 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.
  - 4. 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.

## 2.2 EMERGENCY MANUALS

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

- D. Emergency Procedures: Include the following, as applicable:
  - 1. Instructions on stopping.
  - 2. Shutdown instructions for each type of emergency.
  - 3. Operating instructions for conditions outside normal operating limits.
  - 4. Required sequences for electric or electronic systems.
  - 5. Special operating instructions and procedures.

## 2.3 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
  - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
  - 2. Performance and design criteria if Contractor is delegated design responsibility.
  - 3. Operating standards.
  - 4. Operating procedures.
  - 5. Operating logs.
  - 6. Wiring diagrams.
  - 7. Control diagrams.
  - 8. Piped system diagrams.
  - 9. Precautions against improper use.
  - 10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
  - 1. Product name and model number. Use designations for products indicated on Contract Documents.
  - 2. Manufacturer's name.
  - 3. Equipment identification with serial number of each component.
  - 4. Equipment function.
  - 5. Operating characteristics.
  - 6. Limiting conditions.
  - 7. Performance curves.
  - 8. Engineering data and tests.
  - 9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include the following, as applicable:
  - 1. Startup procedures.
  - 2. Equipment or system break-in procedures.
  - 3. Routine and normal operating instructions.
  - 4. Regulation and control procedures.
  - 5. Instructions on stopping.
  - 6. Normal shutdown instructions.
  - 7. Seasonal and weekend operating instructions.
  - 8. Required sequences for electric or electronic systems.
  - 9. Special operating instructions and procedures.

- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

## 2.4 PRODUCT MAINTENANCE MANUALS

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

# 2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product,

list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
  - 1. Standard maintenance instructions and bulletins.
  - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  - 3. Identification and nomenclature of parts and components.
  - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
  - 1. Test and inspection instructions.
  - 2. Troubleshooting guide.
  - 3. Precautions against improper maintenance.
  - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - 5. Aligning, adjusting, and checking instructions.
  - 6. Demonstration and training video recording, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

## PART 3 - EXECUTION

### 3.1 MANUAL PREPARATION

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

- C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
  - 1. Do not use original project record documents as part of operation and maintenance manuals.
- F. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

# SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

#### 1.1 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 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

### 1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
  - 1. Number of Copies: Submit copies of record Drawings as follows:
    - a. Initial Submittal:
      - 1) Submit one paper-copy set(s) of marked-up record prints.
      - 2) Submit PDF electronic files of scanned record prints and one set(s) of file prints.
      - 3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
    - b. Final Submittal:
      - 1) Submit PDF electronic files of scanned record prints and three set(s) of prints.
      - 2) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit one paper copy and annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

#### PART 2 - PRODUCTS

# 2.1 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. Record data as soon as possible after obtaining it.
  - c. Record and check the markup before enclosing concealed installations.
- 2. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
- 3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
- 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
  - 1. Format: Annotated PDF electronic file.
  - 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
  - 3. Refer instances of uncertainty to Architect for resolution.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
  - 1. Record Prints: Organize record prints and newly prepared record Drawings into manageable 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.

## 2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

- 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
- 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
- 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
- 4. Note related Change Orders, Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file.

# 2.3 RECORD PRODUCT DATA

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

## 2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file.

## PART 3 - EXECUTION

## 3.1 RECORDING AND MAINTENANCE

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

## SECTION 017900 - DEMONSTRATION AND TRAINING

## PART 1 - GENERAL

### 1.1 SUMMARY

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

### 1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
  - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
  - 1. At completion of training, submit complete training manual(s) for Owner's use prepared and bound in format matching operation and maintenance manuals and in PDF electronic file format on compact disc.

# 1.4 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

### 1.5 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 content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

## PART 2 - PRODUCTS

### 2.1 INSTRUCTION PROGRAM

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

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

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

### 3.2 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  - 1. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  - 1. Schedule training with Owner with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

## 3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Architect.
- B. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.
- C. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.
# SECTION 024119 - SELECTIVE DEMOLITION

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Demolition and removal of selected portions of building or structure.
  - 2. Salvage of existing items to be reused or recycled.

#### 1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- B. Schedule of selective demolition activities with starting and ending dates for each activity.
- C. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

#### 1.4 CLOSEOUT SUBMITTALS

A. Inventory of items that have been removed and salvaged.

#### 1.5 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

#### 1.6 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. Hazardous materials will be removed by Owner before start of the Work.
  - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
  - 1. Maintain fire-protection facilities in service during selective demolition operations.
- G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

### 1.7 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

### PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

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

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Perform a survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
- C. Inventory and record the condition of items to be removed and salvaged.

### 3.2 PREPARATION

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

### 3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

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

## 3.4 **PROTECTION**

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
- C. Remove temporary barricades and protections where hazards no longer exist.

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## 3.5 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
  - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  - 3. 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.
  - 4. Maintain fire watch during and for at least 4 hours after flame-cutting operations.
  - 5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  - 6. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
  - 1. Clean salvaged items.
  - 2. Pack or crate items after cleaning. Identify contents of containers.
  - 3. Store items in a secure area until delivery to Owner.
  - 4. Transport items to Owner's storage area off-site.
  - 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
  - 1. Clean and repair items to functional condition adequate for intended reuse.
  - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  - 3. Protect items from damage during transport and storage.
  - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

## 3.6 CLEANING

- A. Remove demolition waste materials from Project site and dispose of them in a construction and demolition waste landfill acceptable to authorities having jurisdiction.
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.
- C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

# SECTION 033000 - CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Owner to provide concrete material not to exceed 10 cubic yards. Contractor is responsible for all forms, reinforcing, labor and other accessories as needed for the complete installation of the concrete.

### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.
- C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.
- D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

## 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

### PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

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

## 2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

### 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from asdrawn steel wire into flat sheets.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

#### 2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  - 1. Portland Cement: ASTM C 150, Type I, gray. Supplement with the following:
    - a. Fly Ash: ASTM C 618, Class F or C.
- B. Normal-Weight Aggregates: ASTM C 33, graded.
- C. Lightweight Aggregate: ASTM C 330, 3/8-inch nominal maximum aggregate size.
- D. Water: ASTM C 94/C 94M and potable.
- E. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.
- F. Lightweight Aggregate: ASTM C 330/C 330M, 3/8-inch nominal maximum aggregate size.

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

### 2.5 ADMIXTURES

- A. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
  - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II

### 2.6 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

#### 2.7 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
- B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

## 2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

### 2.9 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

### 2.10 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
  - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- D. Proportion normal-weight concrete mixture as follows:
  - 1. Minimum Compressive Strength: 4000 psiat 28 days.
  - 2. Maximum Water-Cementitious Materials Ratio: 0.50.
  - 3. Slump Limit: 4 inches, plus or minus 1 inch.
  - 4. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
  - 5. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.

## 2.11 FABRICATING REINFORCEMENT

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

#### 2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.
  - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

### PART 3 - EXECUTION

### 3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

### 3.2 EMBEDDED ITEMS

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

### 3.3 VAPOR RETARDERS

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

## 3.4 STEEL REINFORCEMENT

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

#### 3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting

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

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

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  - 1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
- C. Cold-Weather Placement: Comply with ACI 306.1.
- D. Hot-Weather Placement: Comply with ACI 301.

## 3.7 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces to receive trowel finish.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  - 2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.

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

## 3.8 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
  - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
  - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

#### 3.9 CONCRETE SURFACE REPAIRS

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

## 3.10 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

### END OF SECTION 033000

# SECTION 040110 - MASONRY CLEANING

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section includes cleaning the following:
  - 1. Unit masonry surfaces.

# 1.2 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform masonry-cleaning work in the following sequence:
  - 1. Remove plant growth.
  - 2. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.
  - 3. Remove paint.
  - 4. Clean masonry surfaces.
  - 5. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include material descriptions and application instructions.
  - 2. Include test data substantiating that products comply with requirements.

# 1.4 QUALITY ASSURANCE

- A. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.
- B. Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.
  - 1. Cleaning: Clean an area approximately 25 sq. ft. for each type of masonry and surface condition.
    - a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.

- b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.
- 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

# 1.5 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning work to be performed according to product manufacturers' written instructions and specified requirements.

# PART 2 - PRODUCTS

# 2.1 CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F.
- C. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Prosoco, Inc; Enviro Klean® 2010 All Surface Cleaner or comparable product by one of the following:
    - a. American Building Restoration Products, Inc.
    - b. Diedrich Technologies, Inc.; a Hohmann & Barnard company
    - c. Dumond Chemicals, Inc
    - d. Price Research, Ltd. dba Charles Paint Research
    - e. PROSOCO, Inc

# 2.2 CHEMICAL CLEANING SOLUTIONS

A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.

# PART 3 - EXECUTION

## 3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent paint removers and

chemical cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

- 1. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents according to manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
- 2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
- 3. Neutralize alkaline and acid wastes before disposal.
- 4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
- B. Remove gutters and downspouts and associated hardware adjacent to immediate work area and store during masonry cleaning. Reinstall when masonry cleaning is complete.
  - 1. Provide temporary rain drainage during work to direct water away from building.

# 3.2 CLEANING MASONRY, GENERAL

- A. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 20 feet away by Architect.
- B. Proceed with cleaning in an orderly manner; work from bottom to top of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.
- C. Use only those cleaning methods indicated for each masonry material and location.
  - 1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
  - 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.
    - a. Equip units with pressure gages.
    - b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
    - c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
    - d. For high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
    - e. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F at flow rates indicated.

- D. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.
- E. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.
- F. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces according to chemical-cleaner manufacturer's written instructions; use brush or spray application. Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- G. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
  - 1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
- H. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

# 3.3 PRELIMINARY CLEANING

- A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and plant debris from open joints to whatever depth they occur.
- B. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.
  - 1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.
  - 2. Remove paint and calking with alkaline paint remover.
    - a. Repeat application up to two times if needed.
  - 3. Remove asphalt and tar with solvent-type paste paint remover.
    - a. Apply paint remover only to asphalt and tar by brush without prewetting.
    - b. Allow paint remover to remain on surface for 10 to 30 minutes.
    - c. Repeat application if needed.

- 3.4 CLEANING MASONRY
  - A. Cold-Water Wash: Use cold water applied by high-pressure spray.
  - B. Nonacidic Liquid Chemical Cleaning:
    - 1. Apply cleaner to surface by brush or low-pressure spray.
    - 2. Let cleaner remain on surface for period recommended in writing by chemicalcleaner manufacturer.
    - 3. Rinse with hot water applied by medium-pressure spray to remove chemicals and soil.
    - 4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

## 3.5 FINAL CLEANING

- A. Clean adjacent nonmasonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.
- B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- C. Remove masking materials, leaving no residues that could trap dirt.

END OF SECTION 040110

# SECTION 040120.63 - BRICK MASONRY REPAIR

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Repairing brick masonry.
  - 2. Removing abandoned anchors.

## 1.2 DEFINITIONS

- A. Low-Pressure Spray: 100 to 400 psi; 4 to 6 gpm.
- B. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
- C. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of bricks to freezing and thawing.

## 1.3 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform brick masonry repair work in the following sequence, which includes work specified in this and other Sections:
  - 1. Remove plant growth.
  - 2. Inspect masonry for open mortar joints and point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
  - 3. Remove paint.
  - 4. Preliminary Clean masonry.
  - 5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
  - 6. Repair masonry, including replacing existing masonry with new masonry materials.
  - 7. Rake out mortar from joints to be repointed.
  - 8. Point mortar and sealant joints.
  - 9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
  - 10. Clean Masonry.
  - 11. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.
- B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in bricks according to "Brick Masonry Patching" Article. Patch holes in mortar joints according to Section 040120.64 "Brick Masonry Repointing."

- 1.4 ACTION SUBMITTALS
  - A. Product Data: For each type of product.
    - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
    - 2. Include recommendations for product application and use.
    - 3. Include test data substantiating that products comply with requirements.
  - B. Shop Drawings:
    - 1. Include plans, elevations, sections, and locations of replacement bricks on the structure, showing relation of existing and new or relocated units.
    - 2. Show provisions for expansion joints or other sealant joints.
    - 3. Show provisions for flashing, lighting fixtures, conduits, and weep holes as required.
    - 4. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.
  - C. Samples for Verification: For the following:
    - 1. Each type of brick unit to be used for replacing existing units. Include sets of Samples to show the full range of shape, color, and texture to be expected. For each brick type, provide straps or panels containing at least four bricks. Include multiple straps for brick with a wide range.
    - 2. Each type of patching compound in the form of briquettes, at least 3 inches long by 1-1/2 inches wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.
    - 3. Accessories: Each type of accessory and miscellaneous support.
- 1.5 DELIVERY, STORAGE, AND HANDLING
  - A. Deliver bricks to Project site strapped together in suitable packs or pallets or in heavyduty cartons and protected against impact and chipping.
  - B. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
  - C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
  - D. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
  - E. Store sand where grading and other required characteristics can be maintained and contamination avoided.
  - F. Handle bricks to prevent overstressing, chipping, defacement, and other damage.

# 1.6 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed according to product manufacturers' written instructions and specified requirements.
- B. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

# PART 2 - PRODUCTS

# 2.1 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain each type of material for repairing brick masonry (brick, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

## 2.2 MASONRY MATERIALS

- A. Face Brick: As required to complete brick masonry repair work.
  - 1. Brick Matching Existing: Units with colors, color variation within units, surface texture, size, and shape that match existing brickwork.
    - a. For existing brickwork that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range and variation rather than brick that matches an individual color within that range.
  - 2. Special Shapes:
    - a. Provide molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.
    - b. Provide specially ground units, shaped to match patterns, for arches and where indicated.
    - c. Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are unacceptable procedures for fabricating special shapes.
  - 3. Tolerances as Fabricated: According to tolerance requirements in ASTM C216, Type FBX.
- B. Building Brick: ASTM C62, of same vertical dimension as face brick, for masonry work concealed from view.
  - 1. Grade SW where in contact with earth.
  - 2. Grade SW, MW, or NW for concealed backup.

# 2.3 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I may be used for cold-weather construction; white where required for color matching of mortar.
  - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Mortar Sand: ASTM C144.
  - 1. Exposed Mortar: Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
  - 2. Colored Mortar: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
- D. Water: Potable.

# 2.4 ACCESSORY MATERIALS

- A. Setting Buttons and Shims: Resilient plastic, nonstaining to masonry, sized to suit joint thicknesses and bed depths of bricks, less the required depth of pointing materials unless removed before pointing.
- B. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.
- C. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
  - 1. Previous effectiveness in performing the work involved.
  - 2. Minimal possibility of damaging exposed surfaces.
  - 3. Consistency of each application.
  - 4. Uniformity of the resulting overall appearance.
  - 5. Do not use products or tools that could leave residue on surfaces.

## 2.5 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
- B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.
  - 1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by

a satisfactory history of performance.

- C. Do not use admixtures in mortar unless otherwise indicated.
- D. Mixes: Mix mortar materials in the following proportions:
  - 1. Rebuilding : ASTM C270, Proportion Specification, 1 part portland cement, 1 part lime, and 6 parts sand.
  - 2. Pigmented, Colored Mortar: Add mortar pigments to produce exposed, setting (rebuilding) mortar of colors required.

# PART 3 - EXECUTION

# 3.1 PROTECTION

- A. Prevent mortar from staining face of surrounding masonry and other surfaces.
  - 1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
  - 2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
  - 3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.
- B. Remove gutters and downspouts and associated hardware adjacent to masonry and store during masonry repair. Reinstall when repairs are complete.
  - 1. Provide temporary rain drainage during work to direct water away from building.

# 3.2 MASONRY REPAIR, GENERAL

A. Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from 20 feet away by Architect.

## 3.3 ABANDONED ANCHOR REMOVAL

- A. Remove abandoned anchors, brackets, wood nailers, and other extraneous items no longer in use unless indicated to remain.
  - 1. Remove items carefully to avoid spalling or cracking masonry.
  - 2. Notify Architect before proceeding if an item cannot be removed without damaging surrounding masonry. Do the following where directed:
    - a. Cut or grind off item approximately 3/4 inch beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
    - b. Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding

manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.

3. Patch hole where each item was removed unless directed to remove and replace bricks.

# 3.4 BRICK REMOVAL AND REPLACEMENT

- A. Remove bricks that are damaged, spalled, or deteriorated or are to be reused. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
  - 1. When removing single bricks, remove material from center of brick and work toward outside edges.
- B. Support and protect remaining masonry that surrounds removal area.
- C. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
- D. Notify Architect of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.
- E. Remove in an undamaged condition as many whole bricks as possible.
  - 1. Remove mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.
  - 2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
  - 3. Store brick for reuse. Store off ground, on skids, and protected from weather.
  - 4. Deliver cleaned brick not required for reuse to Owner unless otherwise indicated.
- F. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for brick replacement.
- G. Replace removed damaged brick with other removed brick in good condition, where possible, or with new brick matching existing brick. Do not use broken units unless they can be cut to usable size.
- H. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.
  - 1. Maintain joint width for replacement units to match existing joints.
  - 2. Use setting buttons or shims to set units accurately spaced with uniform joints.
- I. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter ends with enough mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C67 initial

rates of absorption (suction) of more than 30 g/30 sq. in. per min. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.

- 1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
- 2. Rake out mortar used for laying brick before mortar sets according to Section 040120.64 "Brick Masonry Repointing." Point at same time as repointing of surrounding area.
- 3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.
- J. Curing: Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
  - 1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

# 3.5 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.
  - 1. Do not use metal scrapers or brushes.
  - 2. Do not use acidic or alkaline cleaners.
- B. Clean adjacent nonmasonry surfaces. Use detergent and soft brushes or cloths.
- C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- D. Remove masking materials, leaving no residues that could trap dirt.

## 3.6 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property.
- B. Masonry Waste: Remove masonry waste and legally dispose of off Owner's property.

END OF SECTION 040120.63

# SECTION 040120.64 - BRICK MASONRY REPOINTING

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Repointing joints with mortar.
  - 2. Repointing joints with sealant.

# 1.2 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
  - 1. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

# 1.3 DEFINITIONS

A. Low-Pressure Spray: 100 to 400 psi; 4 to 6 gpm.

# 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to repointing brick masonry including, but not limited to, the following:
    - a. Verify brick masonry repointing specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
    - b. Materials, material application, sequencing, tolerances, and required clearances.
    - c. Quality-control program.
    - d. Coordination with building occupants.

## 1.5 SEQUENCING AND SCHEDULING

- A. Order sand and gray portland cement for pointing mortar immediately after approval of Samples and mockups. Take delivery of and store at Project site enough quantity to complete Project.
- B. Work Sequence: Perform brick masonry repointing work in the following sequence, which includes work specified in this and other Sections:

- 1. Remove plant growth.
- 2. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
- 3. Remove paint.
- 4. Preliminary Clean masonry.
- 5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
- 6. Repair masonry, including replacing existing masonry with new masonry materials.
- 7. Rake out mortar from joints to be repointed.
- 8. Point mortar and sealant joints.
- 9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
- 10. Clean Masonry.
- 11. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.
- C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in bricks according to Section 040120.63 "Brick Masonry Repair." Patch holes in mortar joints according to "Repointing" Article.

# 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include recommendations for product application and use.
  - 3. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and locations of repointing work on the structure.
  - 2. Show provisions for expansion joints or other sealant joints.
  - 3. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.
- C. Samples for Initial Selection: For the following:
  - 1. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
    - a. Have each set contain a close color range of at least three Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
    - b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.

- 2. Sealant materials.
- 3. Include similar Samples of accessories involving color selection.

# 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For brick masonry repointing specialist.
- B. Preconstruction Test Reports: For existing bricks and mortar.
- C. Quality-control program.

## 1.8 QUALITY ASSURANCE

- A. Brick Masonry Repointing Specialist Qualifications: Engage an experienced brick masonry repointing firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repointing work.
  - 1. Field Supervision: Brick masonry repointing specialist firms shall maintain experienced full-time supervisors on Project site during times that brick masonry repointing work is in progress.
- B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.
- C. Mockups: Prepare mockups of brick masonry repointing to demonstrate aesthetic effects and to set quality standards for materials and execution.
  - 1. Repointing: Rake out joints in two separate areas, each approximately 36 inches high by 48 inches wide for each type of repointing required, and repoint one of the areas.
  - Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

# 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- 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 hydrated lime in manufacturer's original and unopened containers. Discard lime

if containers have been damaged or have been opened for more than two days.

D. Store sand where grading and other required characteristics can be maintained and contamination avoided.

# 1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits: Repoint mortar joints only when air temperature is between 40 and 90 deg F and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- C. Cold-Weather Requirements: Comply with the following procedures for mortar-joint pointing unless otherwise indicated:
  - 1. When air temperature is below 40 deg F, heat mortar ingredients and existing masonry walls to produce temperatures between 40 and 120 deg F.
  - 2. When mean daily air temperature is below 40 deg F, provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for seven days after pointing.
- D. Hot-Weather Requirements: Protect mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F and above unless otherwise indicated.

# PART 2 - PRODUCTS

# 2.1 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain each type of material for repointing brick masonry (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

# 2.2 ACCESSORY MATERIALS

- A. Sealant Materials:
  - 1. Sealant manufacturer's standard elastomeric sealant(s) of base polymer and characteristics indicated below and according to applicable requirements in Section 079200 "Joint Sealants."
    - a. Type: Single-component, nonsag urethane sealant.

- 2. Colors: Provide colors of exposed sealants to match colors of mortar adjoining installed sealant unless otherwise indicated.
- B. Joint-Sealant Backing:
  - 1. Cylindrical Sealant Backings: ASTM C1330, 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.
  - 2. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended in writing by sealant manufacturer for preventing sealant from adhering to rigid, inflexible, joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
- C. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.
- D. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
  - 1. Previous effectiveness in performing the work involved.
  - 2. Minimal possibility of damaging exposed surfaces.
  - 3. Consistency of each application.
  - 4. Uniformity of the resulting overall appearance.
  - 5. Do not use products or tools that could leave residue on surfaces.

## 2.3 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
  - 1. Mixing Pointing Mortar: Thoroughly mix cementitious materials and sand together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this dampened condition for 15 to 30 minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one hour of final mixing; do not retemper or use partially hardened material.
- B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.
  - 1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.
- C. Do not use admixtures in mortar unless otherwise indicated.

- D. Mixes: Mix mortar materials in the following proportions:
  - 1. Pointing Mortar by Type: ASTM C270, Proportion Specification, Type N unless otherwise indicated; with cementitious material limited to portland cement and lime Add mortar pigments to produce mortar colors required.

# PART 3 - EXECUTION

# 3.1 PROTECTION

- A. Prevent mortar from staining face of surrounding masonry and other surfaces.
  - 1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
  - 2. Keep wall area wet below pointing work to discourage mortar from adhering.
  - 3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.
- B. Remove gutters and downspouts and associated hardware adjacent to masonry and store during masonry repointing. Reinstall when repointing is complete.
  - 1. Provide temporary rain drainage during work to direct water away from building.

## 3.2 MASONRY REPOINTING, GENERAL

A. Appearance Standard: Repointed surfaces are to have a uniform appearance as viewed from 20 feet away by Architect.

## 3.3 REPOINTING

- A. Rake out and repoint joints to the following extent:
  - 1. All joints in areas indicated.
  - 2. Joints indicated as sealant-filled joints.
  - 3. Joints at locations of the following defects:
    - a. Holes and missing mortar.
    - b. Cracks that can be penetrated 1/4 inch or more by a knife blade 0.027 inch thick.
    - c. Cracks 1/16 inch or more in width and of any depth.
    - d. Hollow-sounding joints when tapped by metal object.
    - e. Eroded surfaces 1/4 inch or more deep.
    - f. Deterioration to point that mortar can be easily removed by hand, without tools.
    - g. Joints filled with substances other than mortar.
- B. Do not rake out and repoint joints where not required.

- C. Rake out joints as follows, according to procedures demonstrated in approved mockup:
  - 1. Remove mortar from joints to depth of 2-1/2 times joint width and not less than that required to expose sound, unweathered mortar. Do not remove unsound mortar more than 2 inches deep; consult Architect for direction.
  - 2. Remove mortar from brick and other masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
  - 3. Do not spall edges of brick or other masonry units or widen joints. Replace or patch damaged brick or other masonry units as directed by Architect.
- D. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.
- E. Pointing with Mortar:
  - 1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
  - 2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch until a uniform depth is formed. Fully compact each layer, and allow it to become thumbprint hard before applying next layer.
  - 3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than 3/8 inch. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
  - 4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
  - 5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
  - 6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.
- F. Pointing with Sealant: Comply with Section 079200 "Joint Sealants." and as follows:
  - 1. After raking out, keep joints dry and free of mortar and debris.
  - 2. Clean and prepare joint surfaces. Prime joint surfaces unless sealant manufacturer recommends against priming. Do not allow primer to spill or migrate onto adjoining surfaces.
  - 3. Fill sealant joints with specified joint sealant.
    - a. Install cylindrical sealant backing beneath the sealant. Where space is insufficient for cylindrical sealant backing, install bond-breaker tape.
    - b. Install sealant using only proven installation techniques that ensure that sealant is deposited in a uniform, continuous ribbon, without gaps or air

pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding masonry and matching the contour of adjoining mortar joints.

- c. Install sealant as recommended in writing by sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead:
  - 1) Fill joints to a depth equal to joint width, but not more than 1/2 inch deep or less than 1/4 inch deep.
- d. Tool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant from surfaces adjacent to joint.
- e. Tooling shall be done by those experienced in such work. Use tools designed to provide smooth, consistent joints.
- f. Sanded Joints: Immediately after first tooling, apply ground-mortar aggregate to sealant, gently pushing aggregate into the surface of sealant. Lightly retool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant and aggregate from surfaces adjacent to joint.
- g. Do not allow sealant to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces, particularly rough textures. Remove excess and spillage of sealant promptly as the work progresses. Clean adjoining surfaces by the means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.
- G. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

# 3.4 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.
  - 1. Do not use metal scrapers or brushes.
  - 2. Do not use acidic or alkaline cleaners.
- B. Clean adjacent nonmasonry surfaces. Use detergent and soft brushes or cloths.
- C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- D. Remove masking materials, leaving no residues that could trap dirt.

# 3.5 FIELD QUALITY CONTROL

A. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use
of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

B. Notify Architect's Project representatives in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until Architect's Project representatives have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

END OF SECTION 040120.64

## SECTION 042200 - CONCRETE UNIT MASONRY

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Concrete masonry units.
  - 2. Steel reinforcing bars.

#### 1.2 DEFINITIONS

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

# 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For reinforcing steel. Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.
- C. Samples: For each type and color of the following:
  - 1. Exposed CMUs.
  - 2. Pigmented and colored-aggregate mortar.

# 1.4 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of product. For masonry units, include data on material properties.
- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
  - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
  - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

### 1.5 QUALITY ASSURANCE

- A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.
  - 1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high by full thickness.

### PART 2 - PRODUCTS

### 2.1 UNIT MASONRY, GENERAL

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

### 2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
- B. CMUs: ASTM C 90.
  - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3050 psi.
  - 2. Density Classification: Lightweight.

# 2.3 CONCRETE LINTELS

A. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.

### 2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for coldweather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C 91/C 91M.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cemex S.A.B. de C.V.
    - b. Essroc.
    - c. Holcim (US) Inc.
    - d. Lafarge North America Inc.
    - e. Lehigh Hanson; HeidelbergCement Group.
- E. Aggregate for Mortar: ASTM C 144.
  - 1. White-Mortar Aggregates: Natural white sand or crushed white stone.
  - 2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- F. Aggregate for Grout: ASTM C 404.
- G. Water: Potable.

## 2.5 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication.
- C. Masonry-Joint Reinforcement, General: ASTM A 951/A 951M.
  - 1. Interior Walls: Hot-dip galvanized, carbon steel.
  - 2. Wire Size for Side Rods: 0.148-inch diameter.
  - 3. Wire Size for Cross Rods: 0.148-inch diameter.
  - 4. Spacing of Cross Rods: Not more than 16 inches o.c.
  - 5. Provide in lengths of not less than 10 feet , with prefabricated corner and tee units.

### 2.6 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
  - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
  - 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
  - 3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Partition Top Anchors: 0.105-inch-thick metal plate with a 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- C. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.
  - 1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M

## 2.7 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, urethane or PVC.
- B. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

## 2.8 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
  - 3. For reinforced masonry, use portland cement-lime or masonry cement mortar.
- 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.
  - 1. For reinforced masonry, use Type S.
  - 2. For mortar parge coats, use Type S or Type N.

- 3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
- 4. For interior nonload-bearing partitions, Type O may be used instead of Type N.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
  - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
  - 2. Proportion grout in accordance with ASTM C 476, Table 1.
  - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

## PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

A. 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.

### 3.2 TOLERANCES

- A. Dimensions and Locations of Elements:
  - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
  - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
  - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. Lines and Levels:
  - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
  - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
  - 3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
  - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
  - 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.

## C. Joints:

- 1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
- 2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
- 3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

# 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 horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- E. 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.
- F. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

## 3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
  - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
  - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
  - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
  - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs 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. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

### 3.5 MASONRY-CELL FILL

- A. Pour lightweight-aggregate fill into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than 20 feet.
- B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

### 3.6 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
  - 1. Space reinforcement not more than 16 inches o.c.
  - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

#### 3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

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

### 3.8 REINFORCED UNIT MASONRY INSTALLATION

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

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

### 3.9 FIELD QUALITY CONTROL

- A. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- B. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for compressive strength.
- C. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

# 3.10 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
  - 2. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

## 3.11 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soilcontaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
  - 1. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

# SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Framing with dimension lumber.
  - 2. Rooftop equipment bases and support curbs.
  - 3. Wood blocking and nailers.
  - 4. Plywood backing panels.

## 1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

## 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 graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  - 1. Factory mark each piece of lumber with grade stamp of grading agency.
  - 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
  - 3. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

## 2.2 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  - 1. Blocking.
  - 2. Nailers.
  - 3. Rooftop equipment bases and support curbs.
  - 4. Cants.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

- C. Concealed Boards: 19 percent maximum moisture content of any of the following species and grades:
  - 1. Mixed southern pine or southern pine, No. 2 grade; SPIB.
  - 2. Eastern softwoods, No. 2 Common grade; NELMA.
  - 3. Northern species, No. 2 Common grade; NLGA.
  - 4. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

## 2.3 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

## 2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
- B. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

## PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.
- D. Do not splice structural members between supports unless otherwise indicated.
- E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
  - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

- 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
- 3. ICC-ES evaluation report for fastener.

# 3.2 **PROTECTION**

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

## END OF SECTION 061053

# SECTION 079200 - JOINT SEALANTS

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Silicone joint sealants.
  - 2. Urethane joint sealants.
  - 3. Latex joint sealants.
  - 4. Preformed joint sealants.
  - 5. Acoustical joint sealants.

# 1.2 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples: For each kind and color of joint sealant required.
- C. 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.

## 1.3 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Preconstruction compatibility and adhesion test reports.
- C. Preconstruction field-adhesion test reports.
- D. Field-adhesion test reports.
- E. Warranties.

### 1.4 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 years from date of Substantial Completion.

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- 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: Five years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 MATERIALS, GENERAL

- A. Low-Emitting Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
  - 1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- 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.

# 2.2 SILICONE JOINT SEALANTS

- A. Mildew-Resistant Silicone Joint Sealant SS1: ASTM C 920.
  - 1. <u>Basis-of-Design Product</u>: Subject to compliance with requirements, provide 795 building sealant as manufactured by Dow Corning Corporation or comparable product by one of the following:
    - a. <u>Dow Corning Corporation</u>.
    - b. <u>GE Advanced Materials Silicones</u>.
    - c. <u>Pecora Corporation</u>.
    - d. <u>Tremco Incorporated</u>.
  - 2. Type: Single component (S).
  - 3. Grade: nonsag (NS).
  - 4. Class: 50.
  - 5. Uses Related to Exposure: Nontraffic (NT).

## 2.3 URETHANE JOINT SEALANTS

A. Urethane Joint Sealant US1: ASTM C 920.

#### JOINT SEALANTS

- 1. <u>Basis-of-Design Product</u>: Subject to compliance with requirements, provide Ultra as manufactured by Sonneborn, Chem Rex, Inc. or comparable product by one of the following:
  - a. <u>Pecora Corporation</u>.
  - b. <u>Tremco Incorporated</u>.
- 2. Type: Single component (S) or multicomponent (M).
- 3. Grade: nonsag (NS).
- 4. Class: 12.5.
- 5. Uses Related to Exposure: Nontraffic (NT).
- B. Exterior Sealants:
  - 1. Exterior Polyurethane Sealant: Single, non-staining, non-bleeding, non-sagging type; color as selected; ASTM C920, Type S, Grade NS, Class 25, use NT, M, A.
    - a. Acceptable Manufacturers:
      - 1) MasterSeal NP 1 as manufactured by BASF, Shakopee, Minnesota.
      - 2) DYmonic as manufactured by Tremco, Inc., Construction Division, Beachwood, Ohio.
      - 3) Dynatrol I-XL as manufactured by Pecora Corporation, Harleysville, Pennsylvania.
      - 4) Sikaflex 1a as manufactured by Sika Corporation, Lyndhurst, New Jersey.
    - b. Locations:
      - 1) General exterior construction joints.
      - 2) Exterior joints between dissimilar materials.
      - 3) Joints in concrete, masonry, and stone.
      - 4) Joints between concrete and aluminum or metal.
      - 5) Joints between masonry and aluminum or metal.
      - 6) Joints between stone and aluminum or metal.

## 2.4 LATEX JOINT SEALANTS

- A. Latex Joint Sealant LS1: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
  - 1. <u>Basis-of-Design Product</u>: Subject to compliance with requirements, provide AC-20 FTR Acoustical and Insulation Sealant as manufactured by Pecora Corporation or comparable product by one of the following:
    - a. <u>BASF Building Systems</u>.
    - b. <u>Pecora Corporation</u>.
    - c. <u>Tremco Incorporated</u>.

# 2.1 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Pecora Corporation.
- b. Tremco Incorporated.
- c. United States Gypsum Company.
- 2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range.
- B. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.
- C. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.
- D. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

### 2.2 JOINT SEALANT BACKING

- A. 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.
- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

## 2.3 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.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
  - 1. Remove laitance and form-release agents from concrete.
  - 2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.

- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

# 3.2 INSTALLATION

- A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- B. 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.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. 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.
- E. 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.
- F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.

G. 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.

## 3.3 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: US1
  - 1. Joint Locations: Interior
    - a. Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
    - b. All interior masonry joints requiring sealant.
  - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: SS1.
  - 1. Joint Sealant Location: Interior
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    - b. Tile control and expansion joints where indicated.
  - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: LS1.
  - 1. Joint Location: Interior
    - a. Interior joints between dissimilar materials.
    - b. Any application requiring acoustical sealant.
  - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION 079200

# SECTION 081213 - HOLLOW METAL FRAMES

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section includes hollow-metal frames.
- B. Related Requirements:
  - 1. Section 081416 "Flush Wood Doors" for wood doors installed in hollow-metal frames.

#### 1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include elevations, frame profiles, metal thicknesses, preparations for hardware, and other details.
- C. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. <u>Manufacturers</u>: Subject to compliance with requirements, provide products by one of the following:
  - 1. <u>Ceco Door Products;</u> an Assa Abloy Group company.
  - 2. <u>Curries Company</u>; an Assa Abloy Group company.
  - 3. <u>Deansteel</u>.
  - 4. <u>MPI Group, LLC (The)</u>.
  - 5. <u>Republic Doors and Frames</u>.
  - 6. <u>Steelcraft</u>; an Ingersoll-Rand company.

## 2.2 INTERIOR FRAMES

- A. Heavy-Duty Frames: SDI A250.8, Level 2.
  - 1. Physical Performance: Level B according to SDI A250.4.
  - Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
    a. Construction: Full profile welded.
    Exposed Finish: Factory Prime.

### 2.3 FRAME ANCHORS

- A. Jamb Anchors:
  - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inchthick, with corrugated or perforated straps not less than 2 inches wide by 10 incheslong; or wire anchors not less than 0.177 inchthick.
  - 2. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
- B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch and as follows:

#### 2.4 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B.
- C. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Power-Actuated Fasteners in Concrete: From corrosion-resistant materials.

### 2.5 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
  - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

- 2. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
- 3. Jamb Anchors: Provide number and spacing of anchors as follows:
  - a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 incheso.c., to match coursing.
  - b. Stud-Wall Type: Locate anchors not more than 18 inchesrom top and bottom of frame. Space anchors not more than 32 incheso.c.
  - c. Compression Type: Not less than two anchors in each frame.
- 4. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
  - 1. Reinforce frames to receive nontemplated, mortised, and surface-mounted hardware.
  - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- D. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.
  - 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollowmetal work.
  - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
  - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior frames.
  - 4. Provide loose stops and moldings on inside of hollow-metal work.
  - 5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

# 2.6 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
  - 1. Shop Primer: SDI A250.10.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
  - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

- a. At fire-rated openings, install frames according to NFPA 80.
- b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
- c. Install frames with removable stops located on secure side of opening.
- d. Install door silencers in frames before grouting.
- e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
- f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
- g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
- 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
  - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
- 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
- 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
- 5. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
  - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
  - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
  - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
  - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

#### 3.2 ADJUSTING AND CLEANING

- A. Final Adjustments: Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

#### END OF SECTION 081213

# SECTION 081433 - STILE AND RAIL WOOD DOORS

## PART 1 - GENERAL

## 1.1 SUMMARY

A. Section Includes:1. Interior stile and rail wood doors.

### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
  - 1. Details of construction
  - 2. Door frame construction.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data, including those for stiles, rails, panels, and moldings (sticking); and other pertinent data, including the following:
  - 1. Door schedule indicating door location, type, size, fire protection rating, and swing.
  - 2. Door elevations, dimensions and location of hardware, lite locations, and glazing thickness.
  - 3. Details of frame for each frame type, including dimensions and profile.
  - 4. Clearances and undercuts.
  - 5. Requirements for veneer matching.
- C. Samples: For factory-finished doors and factory-finished door frames.

#### 1.3 QUALITY ASSURANCE

A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Use only materials that comply with referenced standards and other requirements specified.
  - 1. Assemble interior doors, including components, with either dry-use or wet-use adhesives complying with ASTM D5572 for finger joints and with ASTM D5751 for joints other than finger joints.
- B. Panel Products: Any of the following unless otherwise indicated:
  - 1. Particleboard: ANSI A208.1, Grade M-2.

#### STILE AND RAIL WOOD DOORS

- 2. Medium-density fiberboard (MDF,) complying with ANSI A208.2, Grade 130.
- 3. Hardboard complying with ANSI A135.4.
- 4. Veneer-core plywood.
- C. Safety Glass: Provide products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.

## 2.2 INTERIOR STILE AND RAIL WOOD DOORS

- A. Interior Stile and Rail Wood Doors: Interior custom doors complying with AWI, AWMAC, and WI's Architectural Woodwork Standards and with other requirements specified.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. JELD-WEN, Inc. Charlotte, North Carolina.
    - b. Simpson Door Company, McCleary, Washington.
    - c. Marshfield Door Systems, Inc., Marshfield, Wisconsin.
    - d. VT Industries, Inc.
  - 2. Performance Grade: WDMA I.S. 6A Standard Duty.
  - 3. Grade: Custom.
  - 4. Panel Designs: Match existing. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
  - 5. Finish: **Opaque**. Match existing
  - 6. Wood Species and Cut for Transparent Finish: Match existing
  - 7. Door Construction for Opaque Finish:
    - a. Stile and Rail Construction: Veneered, structural composite lumber. Match existing.

## 2.3 STILE AND RAIL WOOD DOOR FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:
  - 1. Clearances:
    - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
    - b. Provide 1/2 inch from bottom of door to top of decorative floor finish or covering.
    - c. Where threshold is shown on Drawings or scheduled, provide not more than 3/8 inch from bottom of door to top of threshold.
    - d. Comply with NFPA 80 requirements for fire-rated doors.
  - 2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
- B. Fabricate stile and rail wood doors in sizes indicated for field fitting.
- C. Factory machine doors for hardware that is not surface applied.

- 1. Locate hardware to comply with DHI-WDHS-3.
- 2. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
- 3. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.

# 2.4 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
  - 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
  - 2. Finish faces, all four edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Opaque Finish:
  - 1. Architectural Woodwork Standards Grade: Custom.
  - 2. Match Existing

### PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
- B. Install doors and frames to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Job-Fitted Doors:
  - 1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
    - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
  - 2. Machine doors for hardware.
  - 3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- E. Factory- Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

### 3.2 FIELD QUALITY CONTROL

A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

# 3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

## END OF SECTION 081433

# SECTION 08 51 13 - ALUMINUM WINDOWS

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes aluminum windows for exterior locations.
- B. Related Requirements:
  - 1. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.

# 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
  - 3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
  - 4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
  - 5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: For aluminum windows.
  - 1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
- C. Samples: For each exposed product and for each color specified, 2 by 4 inches in size.

- D. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.
- 1.4 INFORMATIONAL SUBMITTALS
  - A. Qualification Data: For manufacturer and Installer.
  - B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.
  - C. Field quality-control reports.
  - D. Sample Warranties: For manufacturer's warranties.

# 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.
- C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Build mockup of typical wall area as shown on Drawings.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

# 1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure to meet performance requirements.
    - b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
    - c. Faulty operation of movable sash and hardware.
    - d. Deterioration of materials and finishes beyond normal weathering.
    - e. Failure of insulating glass.
  - 2. Warranty Period:

- a. Window: 10 years from date of Substantial Completion.
- b. Glazing Units: 10 years from date of Substantial Completion.
- c. Aluminum Finish: 10 years from date of Substantial Completion.

# PART 2 - PRODUCTS

# 2.1 SOURCE LIMITATIONS

A. Obtain aluminum windows from single source from single manufacturer.

# 2.2 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
  - 1. Window Certification: AAMA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
  - 1. Minimum Performance Class: Architectural Grade Window F-HC100 / F-AW100 / AW-PG100-FW
- C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.48 Btu/sq. ft. x h x deg F
- D. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

# 2.3 ALUMINUM WINDOWS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer Company, Inc 8400TL and 84010TL or comparable product by one of the following:
  - 1. EFCO Corporation
  - 2. Kawneer Company, Inc.; Arconic Corporation
  - 3. OldCastle BuildingEnvelope (OBE)
- B. Types: Provide the following types in locations indicated on Drawings:
  - 1. Fixed.

- C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
  - 1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
- D. Insulating-Glass Units: ASTM E2190.
  - 1. Glass: ASTM C1036, Type 1, Class 1, q3.
    - a. Tint: Clear.
  - 2. Lites: Two.
  - 3. Filling: Fill space between glass lites with air.
  - 4. Low-E Coating: Pyrolytic on second surface.
- E. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.
- F. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
  - 1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

# 2.4 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- E. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.
- F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

# 2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

# 2.6 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Superior-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to

wall flashing and other adjacent construction to produce weathertight construction.

- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

# 3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.
- B. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
  - 1. Keep protective films and coverings in place until final cleaning.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 08 51 13

# SECTION 087100 - DOOR HARDWARE

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Mechanical door hardware for the following:
    - a. Swinging doors.

### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product in each finish specified.
- C. Door hardware schedule.
  - 1. Schedule will include the following:
    - a. Door Index including opening numbers and the assigned Finish Hardware set.

b.	Preface sheet listing	category only and	manufacturer's names	of items	being
	furnished as follows:				_
	CATEGORY	SPECIFIED	SCHEDULED		
	TT:				

Hinges	Manufacturer A	Manufacturer B
Lock sets	Manufacturer X	Manufacturer X
Kick Plates	Open	Manufacturer Z

- c. Hardware Locations: Refer to Article 3.1.C.2 Locations.
- d. Opening Description: Single or pair, number, room locations, hand, active leaf, degree of swing, size, door material, frame material, and UL listing.
- e. Hardware Description: Quantity, category, product number, fasteners, and finish.
- f. Headings that refer to the specified Hardware Set Numbers.
- g. Scheduling Sequence shown in Hardware Sets.
- h. Product data of each hardware item, and shop drawings where required, for special conditions and specialty hardware.
- i. Electrified Hardware system operation description.
- j. "Vertical" scheduling format only. "Horizontal" schedules will be returned "Not Approved."
- k. Typed Copy.
- 1. Double-Spacing.
- m.  $8-1/2 \ge 11$  inch sheets
- n. U.S. Standard Finish symbols or BHMA Finish symbols.
- D. Keying schedule.

# 1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

## 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

## 1.5 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
  - 1. Furnish finish hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.
  - 2. Furnish finish hardware to comply with the requirements of the regulations for public building accommodations for physically handicapped persons of the governmental authority having jurisdiction and to comply with Americans with Disabilities Act.
  - 3. Provide hardware for fire rated openings in compliance with NFPA 80 and state and local building code requirements. Provide only hardware that has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.
- B. Supplier:
  - 1. Mechanical Hardware
    - a. Shall be an established firm dealing in contract builders' hardware. He must have adequate inventory, qualified personnel on staff and be located within 100 miles of the project. The distributor must be a factory-authorized dealer for all materials required. The supplier shall be or have in employment an Architectural Hardware Consultant (AHC).
- C. Installer:
  - 1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
  - 2. Installer shall have warehousing facilities in Project's vicinity.
  - 3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- D. Pre-installation Meeting:
  - 1. Before hardware installation, General Contractor/Construction Manager will request a hardware installation meeting be conducted on the installation of hardware; specifically that of locksets, closers, exit devices, overhead stops and coordinators. Manufacturer's representatives of the above products, in conjunction with the hardware supplier for the project, shall conduct the meeting. Meeting to be held at job site and attended by installers of hardware for aluminum, hollow metal and wood doors. Meeting to address proper coordination and installation of hardware, per finish hardware schedule for this specific project, by using installation manuals, hardware schedule, templates, physical product samples and installation videos.
  - 2. When any electrical or pneumatic hardware is specified this meeting shall also include the following trades/installers: Electrical, Security, Alarm systems and Architect.
- 3. Convene one week or more prior to commencing work of this Section.
- 4. The Hardware Supplier shall include the cost of this meeting in his proposal.
- E. Manufacturer:
  - 1. Obtain each type of hardware (latch and locksets, hinges, closers, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.
  - 2. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.

## 1.6 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. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
    - a. Exit Devices: Two years from date of Substantial Completion.
    - b. Manual Closers: 10 years from date of Substantial Completion.
    - c. Concealed Floor Closers: 10 years from date of Substantial Completion.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS:

- A. Furnish each category with the products of only one manufacturer unless specified otherwise; this requirement is mandatory whether various manufacturers are listed or not.
- B. Provide the products of manufacturer designated or if more than one manufacturer is listed, the comparable product of one of the other manufacturers listed. Where only one manufacturer or product is listed, it is understood that this is the owner's Building Standard and "no substitution" is allowed.
- C. The first manufacture listed for each product is the manufacture used in the hardware sets.

## 2.2 MATERIALS:

- A. Screws and Fasteners:
  - 1. Furnish fasteners of the proper type, size, quantity and finish. Use machine screws and expansion shields for attaching hardware to concrete or masonry, and wall grip inserts at hollow wall construction. Furnish machine screws for attachment to reinforced hollow metal doors and frames and reinforced aluminum doors and frames. Furnish full thread wood screws for attachment to solid wood doors and frames. "TEK" type screws are not acceptable.
  - 2. Sex bolts will not be permitted on reinforced metal doors or wood doors where blocking is specified.
- B. Hinges:

- 1. 1. Quantity: Provide the following, unless otherwise indicated:
  - a. Two Hinges: For doors with heights up to 60 inches (1524 mm).
  - b. Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
  - c. Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
  - d. For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048mm).
- 2. Hinge Sizes: Provide the following, unless otherwise indicated:
  - a. 4-1/2 inches high: For all doors with widths of 36 inches or less.
  - b. 5 inches high: For all doors with widths greater than 36 inches.
- 3. Hinge Base Metal Thickness: Provide the following, unless otherwise indicated:
  - a. Medium Weight Doors with Medium Frequency: 0.134 inches thick.
  - b. Heavy Weight Doors with High Frequency: 0.180 inches thick.
- 4. Hinge Base Metal: Unless otherwise indicated, provide the following:
  - a. Exterior Hinges: Stainless steel, with stainless-steel pin.
  - b. Interior Hinges: Steel, with steel pin.
  - c. Hinges for Fire-Rated Assemblies: Steel, with steel pin.
- 5. Hinge Options: Where indicated in door hardware sets or on Drawings:
  - a. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into groove in hinge pin, prevents removal of pin while door is closed; for out-swinging exterior doors and out-swinging corridor doors with locks.
  - b. Corners: Square.
  - c. Width of Hinges: Shall be sufficient to clear all trim.
- 6. Fasteners: Provide Phillips flat-head screws comply with the following::
  - a. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
  - b. Wood Screws: For wood doors and frames.
  - c. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
  - d. Finish screw heads to match surface of hinges.
- 7. Manufacturers:
  - a. Ives; an Allegion Company (IVE).
  - b. Bommer Industries, Inc. (BOM).
  - c. Hager Companies (HAG).
  - d. McKinney; an Assa Abloy Company (MCK).
- C. Continuous Gear Hinge:
  - 1. General: 6063-T6 aluminum alloy, anodized finish (cap on entire hinge painted if specified). Manufacture to template, uncut hinges non-handed, pinless assembly, three interlocking extrusions, full height of door and frame, lubricated polyacetal thrust bearing, fasteners 410 stainless steel plated and hardened. All hinge profiles to be manufactured to template bearing locations, with standard duty bearing configurations at 5-1/8" spacing with a minimum of 16 bearings: and heavy duty at 2-9/16" spacing with a minimum of 32 bearings. Anodizing of material shall be done after fabrication of components so that all bearing slots are anodized.
  - 2. Length: 1" less than door opening height. Fastener 12-24 x 1/2" #3 Phillips keen form stainless steel self-tapping at aluminum and hollow metal doors, 12- 1/2" #3 Philips, flathead full thread at wood doors.
  - 3. Furnish fire rated hinges "FR" at labeled openings.
  - 4. Manufacturers:
    - a. For Wood and Hollow Metal frames; Manufacturers:
      - 1) Ives; an Allegion Company, 224HD series (IVE).
      - 2) Select Products Ltd., SL24HD series (SEL).

- 3) Pemko, FMHD series (PEM).
- b. For Aluminum and FRP frames;
  - 1) Manufacturers:
    - a) Ives; an Allegion Company, 112HD series (IVE).
    - b) Select Products Ltd., SL11HD series (SEL).
    - c) Pemko, FMSLFHD series (PEM).

# D. Door Bolts:

1. Flush Bolts

a.

- Automatic metal doors:
  - 1) Ives; an Allegion company, FB30 series (IVE).
  - 2) Equal product of any B.H.M.A. member.
- b. Constant Latching: metal doors:
  - 1) Ives; an Allegion company, FB50 series (IVE).
  - 2) Equal product of any B.H.M.A. member.
- c. Constant Latching: wood doors:
  - 1) Ives; an Allegion company, FB60 series (IVE).
  - 2) Equal product of any B.H.M.A. member.
- 2. Dust Proof Strikes furnish with all flush bolts, except at openings having thresholds:
  - a. Manufacturers:
    - 1) Ives; an Allegion company, DP2 (IVE).
    - 2) Equal product of any B.H.M.A. member.
- E. Locks and Latches
  - 1. Bored Locks, Heavy Duty:
    - a. All Bored Locks shall be designed to meet BHMA A156.2, Grade 1 test standard and certified by an independent testing laboratory.
    - b. Locksets shall be manufactured from heavy gauge steel, minimum lockcase thickness 1/8", containing components of steel with a zinc dichromate plating for corrosion resistance.
    - c. Locks are to have a standard 2 <sup>3</sup>/<sub>4</sub>" backset with a full <sup>3</sup>/<sub>4</sub>" throw two-piece stainless steel mechanical anti-friction latchbolt. Deadbolt shall be a full 1" throw, constructed of stainless steel.
    - d. Lockcase shall be easily handed without chassis disassembly by removing handing screw on lockcase and installing in opposite location on reverse side. Changing of door hand bevel from standard to reverse hand shall be done by removing the lockcase scalp plate, and pulling and rotating the latchbolt 180 degrees.
    - e. Lock trim shall be through-bolted to the door to assure correct alignment and proper operation. Lever trim shall have external spring cage mechanism to assist in support of the lever weight.
    - f. Provide strikes with extended lips where required to protect trim from being marred by latch bolt. Provide strike lips that do not project more than 1/8" beyond door frame trim at single doors and have 7/8" lip to center at pairs of 1-3/4" doors.
    - g. Manufacturers:
      - 1) Schlage; an Allegion Company, ND series (SCH).
      - 2) Best; The Stanley Works Company, 93K series (BES).
    - h. Lockset Trim:
      - 1) Schlage, Rhodes
      - 2) Best, 15K
- F. Exit Devices:

- 1. Touchpad Style:
  - a. Exit devices shall be touchpad style, fabricated of brass, bronze, stainless steel, or aluminum, plated to the standard architectural finishes to match the balance of the door hardware.
  - b. All exit devices shall incorporate a fluid damper, which decelerates the touchpad on its return stroke and eliminates noise associated with exit device operation. Touchpad shall extend a minimum of one half of the door width. All latchbolts to be deadlatching type, with a self-lubricating coating to reduce wear.
  - c. End-cap will be sloped to deflect any impact from carts and they shall be flush with the external mechanism case. End caps that overlap and project above the mechanism case are unacceptable. End cap shall utilize a two-point attachment to the mounting bracket.
  - d. Touchpad shall match exit device finish, and shall be stainless steel for US26, US26D, US28, US32, and US32D finishes. Only compression springs will be used in devices, latches, and outside trims or controls.
  - e. Plastic templates shall be included with each exit device to facilitate a quick, easy and accurate installation.
  - f. Strikes shall be roller type and come complete with a locking plate to prevent movement.
  - g. All rim and vertical rod exit devices shall have passed a 5 million(5,000,000) cycle test based on ANSI A156.3, 1994, Grade 1 test standards and certified by an independent testing lab.
  - h. All mortise exit devices shall have passed a 10 million(10,000,000)cycle test based on ANSI A156.3, 1994, Grade 1 test standards and certified by an independent testing lab.
  - i. Provide cylinder dogging on panic exit hardware where noted in hardware sets.
  - j. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.
  - k. Lever trim for exit devices shall be vandal-resistant type, which will travel to a 90degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
  - 1. Manufacturers:
    - 1) Von Duprin; an Allegion Company, 99 series (VON).
  - m. Trim:
    - 1) As specified in sets.
    - 2) Levers to match lockset design where specified.
- G. Surface Door Closers:
  - 1. All Surface Door Closers shall be designed to meet BHMA A156.4, Grade 1 test standards and certified by an independent testing laboratory.
  - 2. Door closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron cylinder. Cylinder body shall be 1 ½" in diameter, and double heat treated pinion shall be 11/16" in diameter with double D slab drive arm connection.
  - 3. Hydraulic fluid shall be of a type requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
  - 4. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and backcheck.
  - 5. All closers shall have solid forged steel main arms (and forged forearms for parallel arm closers).

- 6. All surface mounted mechanical closers shall be certified to exceed ten million (10,000,000) full load cycles by a recognized independent testing laboratory.
- 7. Closers will have Powder coating finish certified to exceed 100 hours salt spray testing by ETL, an independent testing laboratory used by BHMA for ANSI certification.
- 8. Refer to door and frame details and furnish accessories such as drop plates, panel adapters, spacers and supports as required to correctly install door closers. State degree of door swing in the hardware schedule.
- 9. Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.
- 10. Manufacturers:
  - a. LCN; an Allegion Company, 4000 series (LCN).
- H. Door Operators
  - 1. Low Energy ADA Special Closers
    - a. Where "Low Energy Power Operated Door" as defined by ANSI Standard A156.19 is indicated for doors required to be accessible to the disabled, provide electrically powered operators complying with the ADA requirements for opening force and time to close standards.
    - b. Full closing force shall be provided when the power or assist cycle ends.
    - c. Modular design, adjustments easily accessible from the front, UL listed for use on labeled doors.
    - d. Shall have "Second Chance" function to accommodate momentary resistance, "Breakaway" function in the electronically controlled clutch, "Soft Start" motor control function and "Maintain Hold-Open Switch" to hold the door open at 90 degree.
    - e. Shall have built in 12V and 24V power supply for actuators, card readers, electric strikes and magnetic door locks, inputs for both swing and stop side sensors and available to accept either 120VAC or 220VAC input power. All wiring connections between operator modules made by easy-to-handle electrical connectors. Shall comply with both UL and NEC requirements for Class 1 and Class 2 wiring by providing separate conduits for each.
    - f. Shall have seven independent electronic adjustments to tailor the operator for specific site conditions. Opening speed, holding force at 90 deg., sequential trigger and time delay, hold-open time at 90 deg., opening force, clutch "breakaway" force setting, electric strike trigger and time delay.
      - 1) Shall have separate and independent adjustments for back check, main speed and latch speed.
    - g. Furnish actuators and other controls as shown in Hardware Sets.
    - h. Manufacturers:
      - 1) LCN; an Allegion Company, 4600 series (LCN).
- I. Door Trim:
  - 1. Push Plates: 6 x 16 x .050 inches. If stile widths will not accept 6", provide stile width less 2".
  - 2. Pull, Offset: One inch round rod, 90 degree offset, 10" centers.
  - 3. Pull Plates: 4 x 16 x .050 inches. 10" center.
  - 4. Manufacturers:
    - a. Ives; an Allegion Company, series as listed in sets (IVE).
    - b. Equal products from any member of B.H.M.A.
- J. Protection Plates:

- 1. Door Armor Plates:
  - a. Furnish beveled on 4 edges, countersunk screws, .050 inches thick x 36" high x 1-1/2" less door width for the push side on single doors and 1" less door width for the pull side on single doors and push or pull side on pairs.
- 2. Kick Plates:
  - a. Furnish beveled on 4 edges, countersunk screws, .050 inches thick x 10" high x 1-1/2" less door width for the push side on single doors and 1" less door width for the pull side on single doors and push or pull side on pairs.
- 3. Mop Plates:
  - a. Furnish beveled on 4 edges, countersunk screws, .050 inches thick x 4" high x 1-1/2" less door width for the push side on single doors and 1" less door width for the pull side on single doors and push or pull side on pairs.

# 4. Manufacturers:

- a. Ives; an Allegion Company, 8400 series (IVE).
- b. Equal products of any B.H.M.A. manufacturer.
- K. Door Stops:
  - 1. Wall Bumpers:
    - a. Wrought, forged, or cast, approximately 2-1/2 inch diameter, convex or concave rubber center, concealed fasteners.
      - 1) Ives; an Allegion Company, WS402 (IVE).
      - 2) Equal products of any B.H.M.A. manufacturer.
  - 2. Automatic Wall Holder:
    - a. Products specified by series only; cast brass or aluminum. Heaving duty bumper to deaden sound and shock.
      - 1) Ives; an Allegion Company, WS40 (IVE).
      - 2) Equal products of any B.H.M.A. manufacturer.
  - 3. Overhead Stops and Holders:
    - a. Size per manufacturer's selector chart. Plastic end caps, hold open mechanisms and shock blocks are not allowed. End caps must be finished same as balance of unit.
    - b. Manufacture products using base material of Brass/Bronze for US3, US4, & US10B finished products and 300 Stainless Steel for US32 & US32D finished products.
    - c. Manufacturers:
      - 1) Glynn-Johnson; an Allegion Company, series as listed in sets (GLY).
      - 2) Equal products of any BHMA manufacturer.
- L. Thresholds and Gasketing:
  - 1. Thresholds:
    - a. 1/2" high 5" wide. Cope at jambs.
    - b. Furnish full wall opening width when frames are recessed.
    - c. Cope in front of mullions if thresholds project beyond door faces.
    - d. Furnish with non-ferrous Stainless Steel Screws and Lead Anchors.
      - 1) National Guard Products Inc. as listed in sets (NGP).
      - 2) Equal of Zero or Reese
  - 2. Door Sweeps:
    - a. Surface Sweeps:
      - 1) National Guard Products Inc., (NGP).
      - 2) Equal by Zero or Reese
  - 3. Meeting Stile Gasketing:
    - a. 2 Pc. Nylon brush type to seal gap between pairs of doors.

- 1) National Guard Products Inc., (NGP).
- 2) Equal by Zero or Reese
- 4. Perimeter Gasketing:
  - a. Apply to head and jamb stops.
  - b. Solid Bar stock all sides
    - 1) National Guard Products Inc., (NGP).
    - 2) Equal by Zero
    - 3) Equal by Reese
- 5. Fire and Smoke Seals:
  - a. Gaskets must comply with UBC7.2 (1997) Part 1 & 2, UL1784 (1995) NFPA 105 (1999) for use on (Category 'B') 90 minute wood door assemblies:
  - b. Perimeter Seals:
    - 1) National Guard Products Inc., (NGP).
    - 2) Zero
    - 3) Reese
- M. Electrified Hardware
  - 1. Power Transfers:
    - a. Transfer power from door frame to edge of door, UL listed R4504.
    - b. Power transfer to be concealed when door is closed.
    - c. Manufacturers:
      - 1) Von Duprin; an Allegion Company, EPT series (VON).
  - 2. Power Supplies:
    - a. Universal 120-240 VAC input, low voltage DC regulated and filtered, fused primary input, NEMA 1 enclosure, high voltage protective cover, 12/24 VDC output field selectable with jumper, single polarized connector for distribution board.
    - b. Provide amperes greater than that of loads.
    - c. Manufacturers:
      - 1) Von Duprin; an Allegion company, PS series (VON).
  - 3. Magnetic Door Releases:
    - a. Electrically controlled, fail-safe, holds door open until current is interrupted.
    - b. Furnish model to hold door away from wall to allow for any trim or levers on pull side of door.
    - c. Manufacturers:
      - 1) LCN; an Allegion company, SEM 7800 series (LCN).
- N. Miscellaneous Hardware:
  - 1. Silencers: a. Prov
    - Provide silencers for all interior doors without gasketing.
      - 1) Ives; an Allegion Company, SR series (IVE).
      - 2) Equal product of any BHMA manufacturer
  - 2. Drip Caps
    - a. Size drip cap: Door width plus 4"
      - 1) National Guard Products Inc., 16A (NGP).
      - 2) Equal by Zero by Reese
- O. Furnish items not categorized in the above descriptions but specified by manufacturer's names in Hardware Sets.

## 2.3 FINISHES:

1.

A. A. Generally, Dull Chrome, US26D / BHMA 626. Provide finish for each item as indicated in sets.

## 2.4 CYLINDERS, CORES, KEYING, AND KEYS:

- A. Cylinders and Cylinder Housings:
  - Cylinder housings to accept for small format interchangeable cores (SFIC).
    - a. Provide cylinder housings for all hardware components capable of being locked.
    - b. Manufacturers:
      - 1) Best; a Stanley Black and Decker company (BES).
- B. Construction Cores and Keys:
  - 1. Provide cylinder housings with construction cores for use during the construction period. Construction, control and operating keys and cores shall not be part of the Owner's permanent keying system or furnished on the same keyway as the Owner's permanent keying system. When so directed, and in the presence of the Owner's security department or representative, convert construction cores or keying to the final system.
  - 2. Provide the following keys for use during construction:
    - a. 25 each Temporary construction Operating keys.
    - b. 2 each Temporary construction Control Keys.
- C. Permanent Cores, Keying, and Keys:
  - 1. Permanent cores shall be 7–pin, interchangeable core and keyed to owner's requirements.
  - 2. Keying of permanent cores to be determined between a representatives of the Owner and the local Best Access Systems office.
  - 3. Permanent cores and keys prepared according to the accepted keying schedule will be furnished to the Owner by the local Best Access Systems office prior to occupancy.
  - 4. Provide the following cut keys:
    - 2 each Control Keys.
      - 2 each Great Grand/Grand Master Keys.
      - 4 each Master/Sub Master keys per group.
    - 2 each Keys per cylinder.
  - 5. Manufacturers: Best Access Systems; a Stanley Black and Decker company (BES)

## 2.5 TEMPLATES AND HARDWARE LOCATION:

- 1. Furnish hardware made to template. Supply required templates and hardware locations to the door and frame manufacturers.
- 2. Furnish metal template to frame/door supplier for continuous hinge.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

A. General:

- 1. Install hardware according to manufacturer's installations and template dimensions. Attach all items of finish hardware to doors, frames, walls, etc. with fasteners furnished and required by the manufacture of the item.
- 2. Provide blocking/reinforcement for all wall mounted Hardware.
- 3. Reinforced hollow metal doors and frames and reinforced aluminum door and frames will be drilled and tapped for machine screws.
- 4. Solid wood doors and frames: full thread wood screws. Drill pilot holes before inserting screws.
- 5. Continuous gear hinges attached to hollow metal doors and frames and aluminum doors and frames: 12-24 x 1/2" #3 Phillips Keenform self-tapping. Use #13 or 3/16 drill for pilot.
- 6. Continuous Gear Hinges require continuous mortar guards of foam or cardboard 1/2" thick x frame height, applied with construction adhesive.
- 7. Install weather-strip gasket prior to parallel arm closer bracket, rim exit device or any stop mounted hardware. Gasket to provide a continuous seal around perimeter of door opening. Allow for gasket when installing finish hardware. Door closers will require special templating. Exit devices will require adjustment in backset.
- B. Installation of Access Control Components:
  - 1. Electrical Contractor shall be responsible for supplying and installing high voltage wiring to the access control panels, automatic door operators and to all doors requiring 110V to their low voltage power supplies. Includes mounting power supply boxes to the walls, supplied through door hardware sets and terminating high voltage to the supplies. Terminations of the low voltage electrified door hardware shall be the responsibility of access control contractor including push buttons for automatic operators. Conduit for access control, automatic operators and all electrified door hardware by electrical contractor.
  - 2. Access Control Supplier/Contractor shall be responsible for supplying and installing all low voltage wiring necessary to complete the installation of wall mounted card readers, reader interfaces, etc. and electrified door hardware/accessories. Low voltage wire terminations of the access control panel, electrified door hardware, and power supplies shall be the responsibility of access control supplier/contractor.

## C. Locations:

- 1. Dimensions are from finish floor to center line of items.
- 2. Include this list in Hardware Schedule.

CATEGORY	DIMENSION
Hinges	Door Manufacturer's Standard
Flush Bolt Levers	72" and 12"
Levers	Door Manufacturer's Standard
Exit Device Touchbar	Per Template
Push Plates	50" Centerline of Plate
Pull Plates	50" Centerline of Pull
Wall Stops/Holders	At Head

- D. Final Adjustment:
  - 1. Provide the services to inspect material furnished and its installation and adjustment, to make final hardware adjustment, and to instruct the Owner's personnel in adjustment, care and maintenance of hardware.
  - 2. Locksets, closers and exit devices shall be inspected by the finish hardware supplier factory representative after installation and adjustment after the HVAC system is in

operation, to insure correct installation and proper adjustment in operation. The finish hardware supplier manufacturer's representative shall prepare a written report stating compliance, and also recording locations and kinds of noncompliance. The original report shall be forwarded to the Architect.

- E. Technical and Warranty Information:
  - 1. At the completion of the project, the technical and warranty information coalesced and kept on file by the General Contractor/Construction Manager shall be given to the Owner or Owner's Agent. In addition to both the technical and warranty information, all factory order acknowledgement numbers supplied to the General Contractor/Construction Manager during the construction period shall be given to the Owner or Owner's Agent. The warranty information and factory order acknowledgement numbers shall serve to both expedite and properly execute any warranty work that may be required on the various hardware items supplied on the project.

# SECTION 092216 - NON-STRUCTURAL METAL FRAMING

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

#### PART 2 - PRODUCTS

#### 2.1 FRAMING SYSTEMS

- A. Steel Studs and Runners: ASTM C 645.
  - 1. Minimum Base-Metal Thickness: 0.0375 inch.
  - 2. Depth: As indicated on Drawings.
- A. Slip-Type Head Joints: Where indicated, provide the following in thickness not less than indicated for studs and in width to accommodate depth of studs:
  - 1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch-deep flanges, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
  - 2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.
    - a. <u>Products</u>: Subject to compliance with requirements, provide one of the following:
      - 1) <u>Dietrich Metal Framing; SLP-TRK Slotted Deflection Track</u>.
      - 2) <u>MBA Building Supplies;</u> FlatSteel Deflection Track.
      - 3) <u>Steel Network Inc. (The)</u>; VertiClip SLD Series.
      - 4) <u>Superior Metal Trim; Superior Flex Track System (SFT)</u>.
      - 5) <u>Telling Industries;</u> Vertical Slip Track.
- A. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
  - 1. Minimum Base-Metal Thickness: 0.018 inch.

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- B. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, 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.
- C. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
  - 1. Minimum Base-Metal Thickness: 0.018 inch.
  - 2. Depth: 7/8 inch.

## 2.2 AUXILIARY MATERIALS

- A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide asphalt saturated organic felt.

## PART 3 - EXECUTION

- 3.1 INSTALLATION, GENERAL
  - A. Installation Standard: ASTM C 754.
    - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 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 blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
  - C. Install bracing at terminations in assemblies.
  - D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

# 3.2 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- 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. Install studs so flanges within framing system point in same direction.

- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
  - 1. 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.
  - 2. 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.
    - a. Install two studs at each jamb unless otherwise indicated.
    - b. 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.
    - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
  - 3. 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.
  - 4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
  - 5. Curved Partitions:
    - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    - b. 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 incheso.c.
- E. Direct Furring:
  - 1. Screw to wood framing.
  - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 incheso.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inchfrom the plane formed by faces of adjacent framing.

# 3.3 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- 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, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
- 3. Do not attach hangers to steel roof deck.
- 4. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
- 5. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
- 6. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Seismic Bracing: Sway-brace suspension systems.
- E. 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.

# SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Interior gypsum board.

#### 1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

#### PART 2 - PRODUCTS

#### 2.1 GYPSUM BOARD, GENERAL

A. Regional Materials: Gypsum panel products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

#### 2.2 INTERIOR GYPSUM BOARD

- A. <u>Manufacturers</u>: Subject to compliance with requirements, provide products by one of the following:
  - 1. <u>American Gypsum</u>.
  - 2. <u>CertainTeed Corp</u>.
  - 3. <u>Georgia-Pacific Gypsum LLC</u>.
  - 4. Lafarge North America Inc.
  - 5. <u>National Gypsum Company</u>.
  - 6. <u>USG Corporation</u>.
- B. High Impact Gypsum Board: ASTM C 1629/C 1629M, Level 3.
  - 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.

## 2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

#### GYPSUM BOARD

- 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
- B. Aluminum Trim: ASTM B 221, Alloy 6063-T5.

## 2.4 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.

# 2.5 AUXILIARY MATERIALS

- A. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
- B. Interior Trim: ASTM C 1047.
  - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
  - 2. Shapes:
    - a. Cornerbead.
    - b. Bullnose bead.
    - c. Expansion (control) joint.

## PART 3 - EXECUTION

## 3.1 APPLYING AND FINISHING PANELS

- A. Comply with ASTM C 840.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. 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.
- D. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inchof open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered

edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

- F. Form control and expansion joints with space between edges of adjoining gypsum panels.
- G. 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.
- H. 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.
- I. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- J. Control Joints: Install control joints at locations indicated on Drawings, according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- K. Install 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.
- L. Prefill open joints and damaged surface areas.
- M. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- N. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.
- O. 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.
  - 2. Level 5: At panel surfaces that will be exposed to view unless otherwise indicated.
    - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

- P. Protect adjacent surfaces from drywall compound and texture finishes and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- Q. Remove and replace panels that are wet, moisture damaged, and mold damaged.

# SECTION 093013 - CERAMIC TILING

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Ceramic mosaic tile.
  - 2. Crack isolation membrane.
  - 3. Metal edge strips.

# 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples:
  - 1. Each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide samples of each color blend.

## 1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

#### 1.4 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Build mockup of each type of floor tile installation.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## PART 2 - PRODUCTS

#### 2.1 PRODUCTS, GENERAL

ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for A. types, compositions, and other characteristics indicated.

#### 2.2 TILE PRODUCTS

- A. Ceramic Mosaic Tile.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of 1. the following:
    - American Olean; Division of Dal-Tile International Inc. a.
    - Crossville, Inc. b.
    - Daltile; Division of Dal-Tile International Inc. c.
  - 2. Composition: Vitreous porcelain.
  - Module Size: 2 by 2 inches. 3.
  - 4. Thickness: 1/4 inch.
  - Face: Plain with cushion edges. 5.
  - Surface: Slip-resistant, with abrasive admixture. 6.
  - 7. Finish: Unglazed.
  - Tile Color and Pattern: Color Locations as indicated on drawings. 8.
    - a. CT1: Daltile/Keystones D200, Desert Gray Speckle (1)
  - 9. Grout Color: As selected by Architect from manufacturer's full range.
  - Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable 10. and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
    - Trim and special shapes as required. Insert other shapes if required. a.

#### 2.3 WATERPROOF MEMBRANE

General: Manufacturer's standard product that complies with ANSI A118.10 and is A. recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

#### 2.4 CRACK ISOLATION MEMBRANE

- General: Manufacturer's standard product, selected from the following, that complies with Α. ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer. 1.
  - Products: Subject to compliance with requirements, provide one of the following:
    - Noble Company (The); Nobleseal CIS. a.
    - N. A. C. Products Inc: ECB membrane. b.
    - Dal-tile Corporation; Dal-Seal CIS с.

## 2.5 MORTAR AND GROUT MATERIALS

- A. Acceptable Manufacturers: As recommended by the manufacturer of the tile for the intended use.
- B. Materials:
  - 1. Portland Cement: ASTM C150, Type 1.
  - 2. Sand: ASTM C144.
  - 3. Water: Potable
  - 4. Latex-Portland Cement Mortar: ANSI A118.4; factory mixed.
  - 5. Grout: ANSI A108.10, A108.9, A118.8, and A118.6.
    - a. Latex-portland cement grout, factory mixed, except as noted below.
    - b. Acid resistant epoxy grout; for floors in all toilet, shower, and drying rooms and in kitchen and serving areas
- C. Color Admixture: Color as selected; type recommended by the manufacturer.

## 2.6 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; nickel silver exposed-edge material.
- C. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
  - 2. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

# 3.3 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
  - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
    - a. Tile floors in wet areas.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
  - 1. Ceramic Mosaic Tile: 1/16 inch.
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
  - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.
- K. Floor Sealer: Apply floor sealer to grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.
- L. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated
- M. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- N. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

# SECTION 095123 - ACOUSTICAL TILE CEILINGS

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Acoustical tiles for interior ceilings.
  - 2. Fully concealed, direct-hung, suspension systems.
- B. Related Requirements:
  - 1. Section 095133 "Acoustical Metal Pan Ceilings" for ceilings consisting of metal-pan units with exposed and concealed suspension systems.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

## 1.3 INFORMATIONAL SUBMITTALS

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

#### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

## PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

## 2.2 ACOUSTICAL TILES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Armstrong World Industries, Inc.
  - 2. CertainTeed Corporation.
  - 3. United States Gypsum Company.
- B. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264.
- C. Classification: Acoustical Board SAT1:
  - 1. Basis of Design Armstrong Ultima Tegular fine texture
  - 2. Color: White.
  - 3. Composition: Mineral Fiber Board
  - 4. LR: Minimum 90 percent.
  - 5. CAC: Minimum 30 to 35
  - 6. Fire Hazard Classification: Class A
  - 7. Edge/Joint Detail: Tegular Beveled.
  - 8. Surface finish: Fine Fissured.
  - 9. Thickness: 3/4 inch.
  - 10. Modular Size: 24 by 24 inches
  - 11. Grid to be Armstrong Interlude XL or approved equal.
- D. Acoustical Board SAT2:
  - 1. Size: 24 inches by 24 inches. Unless otherwise indicated on the drawings.
  - 2. Thickness: Minimum 5/8 inch.
  - 3. Light Reflectance: Minimum 89 percent.
  - 4. CAC Range: Minimum 33.
  - 5. Fire Hazard Classification: Class A
  - 6. Edge: Square.
  - 7. Surface Color: White.
  - 8. Surface Finish: Washable.
  - 9. Product Name: Basis of Design Armstrong kitchen Zone Lay-in Smooth Texture

#### 2.3 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Armstrong World Industries, Inc.
  - 2. CertainTeed Corporation.
  - 3. Chicago Metallic Corp.
  - 4. United States Gypsum Company.
- B. Non-Fire Rated Grid: ASTM C635, heavy duty, exposed T; components die cut and interlocking; Chicago Metallic Snap-Grid 200 System; Armstrong Prelude XL System; USG DX System.

- C. Accessories: Clips, splices, edge moldings, adhesives, and all other accessories required by the manufacturer for suspended grid system.
  - 1. Hold Down Clips: Provide hold down clips at all acoustical ceilings within 10 feet of exterior doors.
- D. Grid Materials: Commercial quality cold rolled steel, hot-dip galvanized.
- E. Grid Finish: Flat white, equal to USG #050. Provide manufacturer's flat black where indicated on Drawings.
- F. Support Channels and Hangers: Galvanized steel; size and type to suit application, to rigidly secure acoustical ceiling system including integral mechanical and electrical components with maximum deflection of 1/360.
- G. Wire Hangers: Galvanized steel wire; ASTM A475, Class C.Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension system that complies with applicable requirements in ASTM C 635/C 635M.

## 2.4 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical tiles in-place during a seismic event.

## 2.5 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.
- B. Layout openings for penetrations centered on the penetrating items.

## 3.2 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

A. Install suspended acoustical tile ceilings according to ASTM C 636/C 636M and manufacturer's written instructions.

- B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.
  - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- C. Arrange directionally patterned acoustical tiles as indicated on reflected ceiling plans.

# SECTION 096513 - RESILIENT BASE AND ACCESSORIES

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Resilient base.
  - 2. Resilient molding accessories.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

#### PART 2 - PRODUCTS

#### 2.1 VINYL BASE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Flexco.
  - 2. Roppe Corporation, USA.
  - 3. Johnsonite, A Tarkett Company
- B. Product Standard: ASTM F1861, Type TV (vinyl, thermoplastic).
  - 1. Group: I (solid, homogeneous).
  - 2. Style and Location:
    - a. Style B, Cove
- C. Minimum Thickness: 0.125 inch.
- D. Height: 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed.
- G. Inside Corners: Job formed.
- H. Colors and Patterns: As selected by architect from the manufactures full range.

#### 2.2 VINYL MOLDING ACCESSORY

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Armstrong World Industries, Inc.
  - 2. Flexco.
  - 3. Johnsonite; A Tarkett Company.
  - 4. Roppe Corporation, USA.
- B. Description: Vinyl misc transition strips.
- C. Profile and Dimensions: As indicated.
- D. Locations: Provide vinyl molding accessories in areas indicated.
- E. Colors and Patterns: As selected by Architect from full range of industry colors.

## 2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

## PART 3 - EXECUTION

## 3.1 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; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are the same temperature as the space where they are to be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

## 3.2 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

#### 3.3 RESILIENT ACCESSORY INSTALLATION

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

# 3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

# SECTION 096813 - TILE CARPETING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes modular carpet tile.
- B. Carpet Tile and adhesive material to be provided by owner and installed by contractor. Contractor to provide all other tools and accessories for proper carpet installation.

#### 1.2 CLOSEOUT SUBMITTALS

A. Maintenance data.

#### 1.3 QUALITY ASSURANCE

A. Installer Qualifications: Certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

#### PART 2 - PRODUCTS

#### 2.1 CARPET TILE 1

- A. Manufacturers: Subject to compliance with requirements, owner to provide products by the following:
  - 1. J and J Flooring.
- B. Color and Pattern: Narrative II 7084 modular, 2998 Epilogue
- C. Total Weight: 19 oz./sq. yd. for finished carpet tile.
- D. Backing System: Nexus modular
- E. Size: 12" x 48".

#### 2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

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B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

# PART 3 - EXECUTION

# 3.1 PREPARATION

- A. General: Comply with CRI's "CRI Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

#### 3.2 INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders.
- H. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.
# SECTION 099123 - INTERIOR PAINTING

## PART 1 - GENERAL

## 1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates.

## 1.2 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples: For each type of paint system and in each color and gloss of topcoat.
- C. Product List: For each product indicated. Include printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

## 1.4 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.

## 1.5 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 specified in Part 3.
    - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
  - 1. Benjamin Moore & Company, Montvale, New Jersey
  - 2. PPG Porter Paints, Louisville, Kentucky
  - 3. The Sherwin-Williams Company, Cleveland, Ohio
- B. EP1: PPG 1092-1 Queen Annes Lace
- C. EP2: Ceiling White
- D. PT1: PPG 1092-1 Queen Annes Lace
- E. PT2: As selected by architect from manufacturer's full range.
- F. PT3: Match existing door frames
- G. PT4: Ceiling White

## 2.2 BLOCK FILLERS

A. Block Filler, Latex, Interior/Exterior: MPI #4.

## 2.3 PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior: MPI #50.

## 2.4 SOLVENT-BASED PAINTS

A. Alkyd, Interior, Semi-Gloss (Gloss Level 5): MPI #47.

### 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. 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.
  - 3. Wood: 15 percent.
  - 4. Gypsum Board: 12 percent.
  - 5. Plaster: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. 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 Manual" applicable to substrates 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 if any.
- 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.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
- B. 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.

## 3.4 CLEANING AND PROTECTION

- A. 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.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### 3.5 INTERIOR PAINTING SCHEDULE

- A. Concrete Masonry Units/Concrete Epoxy Paint (Solid Color).
  - 1. **Moore** One coat block filler, Latex Block Filler, M88. Min. Two coats solid color twocomponent acrylic epoxy paint, Acrylic Epoxy Gloss Coating, M43 plus M44-84 Gloss Catalyst.
  - 2. **PPG Porter -** Block Filler: PPG; 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler. Intermediate coat. Interior water-based epoxy finish PPG Pitt Glaze WB1 Interior Pre-Catalyzed Semi-Gloss (16-510) or Eggshell (16-310)
  - 3. **S-W** -Block Filler: Block filler, latex, interior/exterior: S-W PrepRite Block Filler, B25W25. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat. Topcoat: Light industrial coating, interior, water based, semi-gloss: S-W Pro Industrial Pre-Catalyzed Water Based Epoxy, K46-151 Series.
- B. Gypsum Board Paint.
  - 1. **Moore** One coat latex primer sealer, Fresh Start All-Purpose 100 Percent Acrylic Primer, 023. One coat latex, flat, Moorcraft Super Spec Latex Flat, 275. Min. One coat alkyd, eggshell, Dulamel Eggshell Enamel, C305.
  - 2. **PPG Porter** One Coat PPG; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil (0.025 mm). Two coats PPG; 6-4310XI Speedhide zero Interior Zero VOC Eggshell Latex.
  - 3. **S-W** Gypsum Board: One coat latex primer sealer S-W ProMar 200 Zero VOC Latex Primer, B28W2600 Series. Intermediate Coat: Latex, interior, matching topcoat. Topcoat: Latex, interior, eggshell: S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series.
- C. Metal Frames.
  - 1. **S-W** Prime Coat: Primer, rust-inhibitive, water based: S-W Pro Industrial Pro-Cryl Universal Primer. Intermediate Coat: Water-based acrylic, interior, matching topcoat. Topcoat: Water-based alkyd urethane, semi-gloss: S-W Pro Industrial or approved equal.

END OF SECTION 099123

# SECTION 102113.19 - PLASTIC TOILET COMPARTMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes solid-plastic toilet compartments configured as toilet enclosures and shower compartments.

### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachment details.
- C. Samples for each type of toilet compartment material indicated.

### 1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

#### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

## PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

# 2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Accurate Partitions Corp.; ASI Group.

#### PLASTIC TOILET COMPARTMENTS

- 2. Bradley Corporation.
- 3. Marlite.
- B. Basis of Design: Accurate Partitions Corp. Solid Plastic Partitions with Floor Anchored/Overhead Braced Mounting Style
- C. Toilet-Enclosure Style: Overhead braced
- D. Urinal-Screen Style: Wall hung.
- E. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
  - 1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
  - 2. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum or stainlesssteel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
  - 3. Color and Pattern: One color and pattern.
    - a. Color: Accurate Blue 9509
- F. Pilaster Shoes: Manufacturer's standard design; stainless steel.
- G. Brackets (Fittings):
  - 1. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum or stainless steel.

## 2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
  - 1. Material: Clear-anodized aluminum.
  - 2. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
  - 3. Hinges: Manufacturer's standard, continuous, cam type that swings to a closed or partially open position.
  - 4. Latch and Keeper: Manufacturer's standard, surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
  - 5. Clothing Hooks: Manufacturer's standard clothing hooks outside each shower compartment.
  - 6. Door Bumper: Manufacturer's standard, rubber-tipped bumper at out-swinging doors.
  - 7. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless-steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

## 2.4 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.
- C. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- D. Door Size and Swings: Unless otherwise indicated, provide 24-inch-wide, in-swinging doors for standard toilet compartments and 36-inch-wide, out-swinging doors with a minimum 32-inch-wide, clear opening for compartments designated as accessible.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
  - 1. Maximum Clearances:
    - a. Pilasters and Panels: 1/2 inch.
    - b. Panels and Walls: 1 inch.

# 3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors and doors in entrance screens to return doors to fully closed position.

## END OF SECTION 102113.19

# SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

# PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Public-use washroom accessories.
  - 2. Warm-air dryers.
  - 3. Underlavatory guards.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: Full size, for each exposed product and for each finish specified.

## 1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

#### 1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

#### 1.5 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 15 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 a qualified testing agency, and marked for intended location and application.

### 2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Toilet Tissue (Roll) Dispenser:1. Provided by owner and installed by contractor
- B. Soap Dispenser:
  - 1. Provided by owner and installed by contractor
- C. Sanitary-Napkin Disposal Unit:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AJW Architectural Products.
    - b. ASI-American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corporation.
    - e. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.
    - f. Tubular Specialties Manufacturing, Inc.
  - 2. Mounting: Surface mounted.
  - 3. Door or Cover: Self-closing, disposal-opening cover.
  - 4. Receptacle: Removable.
  - 5. Material and Finish: stainless steel, ASTM A480/A480M No. 4 finish (satin).
- D. Grab Bar :
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AJW Architectural Products.
    - b. ASI-American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corporation.
    - e. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.
  - 2. Mounting: Flanges with concealed fasteners.
  - 3. Material: Stainless steel, 0.05 inch thick.
    - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.
  - 4. Outside Diameter: 1-1/2 inches.
  - 5. Configuration and Length: As indicated on Drawings.
- E. Mirror Unit:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. AJW Architectural Products.
- b. American Specialties, Inc.
- c. Bobrick Washroom Equipment, Inc.
- d. Bradley Corporation.
- e. GAMCO Specialty Accessories; a division of Bobrick.
- f. Tubular Specialties Manufacturing, Inc.
- 2. Frame: Stainless-steel channel
  - a. Corners: Welded and ground smooth.
- 3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
  - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
  - b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
- 4. Size: As indicated on Drawings.

## 2.3 WARM-AIR DRYERS

- A. High-Speed Warm-Air Dryer: Hand Dryers
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Bradley Corporation.
    - b. Excel Dryer Inc.
    - c. World Dryer Corporation.
    - d. Basis of Design: Bradley, Bradley, Aerix Adjustable Speed Warm Air Hand Dryer
  - 2. Description: High-speed, warm-air hand dryer for rapid hand drying.
  - 3. Mounting: Surface mounted, with low-profile design.
  - 4. Unit Dimensions: 10-1/2 inches high by 11-1/2 inches wide by 4 inches deep
  - 5. Operation: Electronic-sensor activated with operation time of 60 seconds.
  - 6. Cover Material and Finish: Stainless steel, 1/16 inch thick, with satin finish.

## 2.4 UNDERLAVATORY GUARDS

- A. Underlavatory Guard:
  - 1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
  - 2. Material and Finish: Antimicrobial, molded plastic, white.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

END OF SECTION 102800

# SECTION 123661 - SIMULATED STONE COUNTERTOPS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Solid-surface-material countertops and backsplashes
  - 2. Solid surface sills

### 1.2 ACTION SUBMITTALS

- A. Product Data: For countertop materials and sinks.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
- C. Samples: For each type of material exposed to view.

## PART 2 - PRODUCTS

## 2.1 SOLID-SURFACE-MATERIAL COUNTERTOPS

- A. Configuration: Provide countertops with the following front and backsplash style:
  - 1. Front: Radius edge with apron, 2 inches high with 3/8-inch radius.
  - 2. Backsplash: Radius edge with 3/8-inch radius.
  - 3. Endsplash: Matching backsplash.
- B. Countertops: 1/2-inch-thick, solid surface material with front edge built up with same material.
- C. Backsplashes: 1/2-inch-thick, solid surface material.

#### 2.2 COUNTERTOP MATERIALS

- A. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.
- B. Adhesives: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. DuPont
  - b. Formica Corporation.
  - c. Centura Solid Surfacing Inc.
  - d. LG Chemical, Ltd.
  - e. Wilsonart International.
- 2. Type: Provide Standard Type unless Special Purpose Type is indicated.
  - Colors and Patterns: E. I. du Pont de Nemours and Company Corian Silver Birch (F) or LG Chemical, Ltd. - Hi-Macs classic White Quartz G04

# 2.3 SOLID-SURFACE-MATERIAL SILLS

- A. Configuration: As indicated on the drawings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. DuPont
  - 2. Formica Corporation.
  - 3. Centura Solid Surfacing Inc.
  - 4. LG Chemical, Ltd.
  - 5. Wilsonart International.
- C. Type: Provide Standard Type unless Special Purpose Type is indicated.
- D. Colors and Patterns: E. I. du Pont de Nemours and Company Corian Silver Birch (F) or LG Chemical, Ltd. Hi-Macs classic White Quartz G04

# PART 3 - EXECUTION

# 3.1 INSTALLATION

A. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

END OF SECTION 123661

# SECTION 144216 - VERTICAL WHEELCHAIR LIFTS

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. This section includes vertical wheelchair lifts (vertical platform lifts) specifications.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: Manufacturer's standard specifications, descriptive literature and certifications, including:
  - 1. Catalog cut-sheets.
  - 2. Sample warranty.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and mounting /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 {Insert portion of Work}.
- C. Manufacturer's Written Instructions, including:
  - 1. Delivery, storage and handling.
  - 2. Preparation and Installation.
  - 3. Maintenance.
- D. Samples: Manufacturer's standard color sheets, showing full range of available colors for {each type of exposed finish} {each type of {Insert unit}}.

## 1.3 CLOSEOUT SUBMITTALS

- A. Maintenance contracts.
- B. Operation and maintenance data.

#### 1.4 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Installers: Acceptable to manufacturer, experienced in performing work of this section and specialized in installation of work similar to that required for this project.

## 1.5 WARRANTY

- A. Warranty: Fully executed, issued in [Owner's] name, and registered with manufacturer, including:
  - 1. Manufacturer's [2-year] limited warranty, from date of substantial completion, covering defects in materials and workmanship for major components.

# PART 2 - PRODUCTS

# 2.1 VERTICAL WHEELCHAIR LIFTS

- Manufacturer: Bruno Independent Living Aids, Inc.; 1780 Executive Dr.; Oconomowoc, WI 53066; Tel: 877-778-699, Email: <u>commercialvlp@bruno.com</u>; Website: <u>www.bruno.com/cvpl.</u>
  - 1. Single Source Responsibility: Provide components and materials in this section from a single manufacturer.
  - 2. Substitutions: In accordance with Section 012500 Substitution Procedures.
- 2.2 Product: VPL-3300B Series Vertical Platform Lifts; designed to lift single passenger with wheelchair, scooter or motorized chair to maximum height of 53 inches (1346mm); weatherproof for interior or exterior use.
  - A. Type:
    - 1. Unenclosed: Designed with minimum floor space required; including, drive tower, platform, platform gate, upper landing gate, automatic folding ramp, and controls.
  - B. Platform size: [Standard 36 by 54 inches (914 by 1372 mm)] [36 by 48 inches (914 by 1219 mm)] [36 by 60 inches (914 by 1524 mm)] [42 by 60 inches (1067 by 1524 mm)].
  - C. Finish and color: Powder coat finish unless noted otherwise, with non-slip additive on walking surfaces; champagne color.
  - D. Rated capacity: 750 pound (340 kg).
  - E. Installation method: Without pit.
  - F. Number of stops: Two.
  - G. Platform configuration: 90 degrees.
  - H. Minimum travel height: 11 inches (279 mm).
  - I. Maximum travel height: 53 inches (1346 mm).
  - J. Components:
    - 1. Drive tower, including:
      - a. Main frame: Steel tube guides with formed steel sheet back; welded construction.

- b. Travel carriage: Steel tube and plate fabrication with 21/4 inch (57 mm) diameter front and back sealed dual-ball- bearing wheels, and adjustable low-friction plastic side stabilizer pads.
- c. DC battery-powered drive system, including:
  - 1) Primary drive: 1/2 hp motor, 1750 rpm, 24V DC permanent magnet, 20 full-load amps, continuous duty.
  - 2) Intermediate reduction: Dual 4L style poly-V belts and pulleys with 3.94:1 reduction.
  - 3) Final drive: 1 inch (25 mm) diameter Acme screw with bronze nut and safety back-up nut.
  - 4) Motor controller: 24V DC relay control with 35A circuit breaker and disconnect.
  - 5) Braking: Precision landing control.
- d. Batteries (2): [12V DC; 17Ah] [12V DC; 34Ah].
- e. Internal battery charger: 5A, 24V DC output with 120V AC, 3A 60 Hz input.
- f. Emergency lowering: Manual hand crank.
- g. Limit switches: Adjustable upper and lower limit switches; upper and lower final limit switches.
- h. Drive tower cabinet: Formed steel sheet enclosure with top; bolted assembly.
- 2. Platform: Formed steel floor with fully enclosed bottom safety panel (unenclosed application only); 42 inch (1067 mm) high sidewalls with 1 inch (25 mm) metal tube frames fitted with sheet metal panels; grab bar; lighted, platform controls with keyed on-off switch, continuous pressure up-down [rocker] [paddle] switch, and emergency stop with audio visual alarm.
- 3. Platform gate: 42 inch (1067 mm) high; 11/2 inch (38 mm) metal tube frame fi with 16 gauge steel panel, hinges, latch plate, and pull handle; electro-mechanical interlock releases gate with platform at lower landing; electronic sensors stop platform from operating unless gate is locked.
- 4. Upper landing gate: [36 inch (9914 mm)] [42 inch (1067 mm)] wide by 42 inch (1067 mm) high; 11/2 inch (38 mm) square by 12 gauge, steel tube frame with 16 gauge steel insert panel, hinges, latch plate, cam locking actuator, and pull handle; 3 inch (76 mm) by 11/2 inch (38 mm) by 12 gauge steel gate posts welded to 5 inch (127 mm) by 43/4 inch (121 mm) by 3/16 inch (5 mm) thick steel mounting fl [electro-mechanical] [electric strike] interlock releases gate with platform at upper landing; electronic sensors stop platform from operating unless gate is locked; landing controls, [built into gate post] [remotely located], with keyed on-off switch and continuous pressure up-down [rocker] [paddle] switch.
- 5. Automatic folding ramp: 16 inch (406 mm) long by width of platform; self-lowering.

K.

## 2.3 ACCESSORIES

- A. Power assisted platform gate operator
- B. Power assisted landing gate operator
- C. Manual hand crank

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that conditions of work previously installed under other sections or contracts are acceptable for installation of vertical wheelchair lifts in accordance with manufacturer's written instructions and approved submittals.
  - 1. Notify Architect of unacceptable conditions upon discovery.
  - 2. Do not proceed with preparation and installation until unacceptable conditions have been corrected.

### 3.2 PREPARATION

A. Prepare mounting locations for installation in accordance with manufacturer's written instructions and approved submittals.

### 3.3 INSTALLATION

A. Install vertical wheelchair lifts in accordance with manufacturer's written instructions and approved submittals.

#### 3.4 CLEANING

- A. Clean-up waste and debris daily during installation.
- B. Upon completion, remove surplus materials, remaining debris, tools and equipment.

# 3.5 **PROTECTION**

- A. Protect installed products from damage during subsequent construction.
- B. Repair damage to adjacent materials caused by installation of vertical wheelchair lifts.

## 3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain.

# END OF SECTION 144216

# SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

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 the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Mechanical sleeve seals.
  - 3. Sleeves.
  - 4. Escutcheons.
  - 5. Grout.
  - 6. Fire-suppression equipment and piping demolition.
  - 7. Equipment installation requirements common to equipment sections.
  - 8. Painting and finishing.
  - 9. Concrete bases.
  - 10. Supports and anchorages.

# 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. CPVC: Chlorinated polyvinyl chloride plastic.

- G. The following are industry abbreviations for rubber materials:
  - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - 2. NBR: Acrylonitrile-butadiene rubber.

### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Mechanical sleeve seals.
  - 2. Escutcheons.
- B. Welding certificates.

### 1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

## 1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

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C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

## 2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### 2.3 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

# 2.4 SLEEVES

- A. Mechanical Sleeve Seals: Modular rubber sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Stainless steel. Include two for each sealing element.
  - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- B. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Galvanized-Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- D. PVC Pipe: ASTM D 1785, Schedule 40.

# 2.5 ESCUTCHEONS & FLOOR PLATES

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- C. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed or exposed-rivet hinge, and spring-clip fasteners.
- D. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- E. Split-Casting Floor Plates: Cast brass with concealed hinge.

## 2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

## PART 3 - EXECUTION

### 3.1 GENERAL PIPING INSTALLATIONS

- A. Fire Suppression Contractor shall be responsible for coring suspended ceiling tiles, to accommodate sprinkler heads.
- B. Install piping free of sags and bends.
- C. Install fittings for changes in direction and branch connections.
- D. Sleeves:
  - 1. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
  - 2. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
  - 3. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
- E. Escutcheons & Floor Plates:
  - 1. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
  - 2. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 3. Install floor plates for piping penetrations of equipment-room floors.
  - 4. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- F. Install unions at final connection to each piece of equipment.

END OF SECTION 210500

# SECTION 211000 - WATER-BASED FIRE-SUPPRESSION 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. Contractor shall provide for complete fire suppression system fully operational including backflow preventer, fire pump (if needed), piping/fittings/valving, alarms, to meet all applicable jurisdictional requirements, including City of Vincennes.
- B. This Section includes the following fire-suppression piping inside the building:
  - 1. Wet-pipe sprinkler systems.
  - 2. Horizontal split case fire pumps. (if needed)
- C. Related Sections include the following:
  - 1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
  - 2. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressuremaintenance pumps, and pump controllers.
  - 3. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

#### 1.3 DEFINITIONS

A. Underground Service-Entrance Piping: Underground service piping below the building.

## 1.4 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig. All components shall be UL and FMG approved.
- B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction and the Owner's insuring agency.
  - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
  - 2. Sprinkler Occupancy Hazard Classifications:
    - a. Building Service Areas: Ordinary Hazard, Group 2

#### WATER-BASED FIRE-SUPPRESSION SYSTEMS

- b. Electrical Equipment Rooms: Ordinary Hazard, Group 1
- c. General Staging Areas: Ordinary Hazard, Group 2
- d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1
- e. Office Areas: Light Hazard
- f. Mercantile Area: Special Density
- 3. Minimum Density for Automatic-Sprinkler Piping Design:
  - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
  - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
  - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 2000-sq. ft. area.
  - d. Mercantile Occupancy Hazard: 0.20 gpm over 2000-sq. ft. area.
- 4. Maximum Protection Area per Sprinkler:
  - a. Office Spaces: 225 sq. ft.
  - b. Storage Areas: 130 sq. ft.
  - c. Mechanical Equipment Rooms: 130 sq. ft.
  - d. Electrical Equipment Rooms: 130 sq. ft.
  - e. Mercantile Area: 120 sq. ft.
  - f. Extended coverage heads shall not be utilized.
- 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
  - a. Light-Hazard Occupancies: 100 gpm
  - b. Ordinary-Hazard Occupancies: 250 gpm
  - c. Mercantile Area: 250 gpm

### 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Piping materials, including sprinkler specialty fittings.
  - 2. Pipe hangers and supports.
  - 3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
  - 4. Fire pumps, including electrical data.
  - 5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
  - 6. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
  - 7. Alarm devices, including electrical data.
- B. Fire-hydrant flow test report.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

- D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 20. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- E. Welding certificates.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For fire pump and sprinkler specialties to include in emergency, operation, and maintenance manuals.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications
  - 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
    - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems."
  - 2. NFPA 20, "Installation of Fire Pumps."

# 1.7 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

## 1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  - 2. Fire pump manufacturer shall be Peerless Pump No Exceptions.

### 2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
  - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern.
  - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

### 2.3 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
  - 1. Cast-Iron Threaded Flanges: ASME B16.1.
  - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
  - 3. Gray-Iron Threaded Fittings: ASME B16.4.
  - 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
  - 5. Steel Threaded Couplings: ASTM A 865.
- B. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller.
  - 1. Grooved-Joint Piping Systems:
    - a. Manufacturers
      - 1) Gruvlok
      - 2) Star Pipe Products; Star Fittings Div.
      - 3) Victaulic Co. of America.
    - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.

- c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.
- C. Threadable thin wall pipe, Schedule 5 pipe and Schedule 7 pipe shall not be utilized.

# 2.4 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed and FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.
- B. Outlet Specialty Fittings:
  - 1. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
  - 2. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.
- C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or lockinglug inlet and outlet, test valve, and orifice and sight glass.
- D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
- E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
- F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

## 2.5 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed and FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum 300-psig pressure rating if valves are components of high-pressure piping system.
- B. Gate Valves with Wall Indicator Posts:
  - 1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, non-rising stem, operating nut, and flanged ends.
  - 2. Manufacturers:
    - a. Grinnell Fire Protection.
    - b. McWane, Inc.; Kennedy Valve Div.
    - c. NIBCO.
    - d. Victaulic Co. of America.
    - e. Reliable Automatic Sprinkler Co., Inc.
- C. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

- 1. Manufacturers:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Star Sprinkler Inc.
  - c. Stockham.
- D. Gate Valves: UL 262, OS&Y type.
  - 1. NPS 2 and Smaller: Bronze body with threaded ends.
    - a. Manufacturers:
      - 1) Crane Co.; Crane Valve Group; Crane Valves.
      - 2) Hammond Valve.
      - 3) NIBCO.
  - 2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
    - a. Manufacturers:
      - 1) Crane Co.; Crane Valve Group; Crane Valves.
      - 2) Hammond Valve.
      - 3) Milwaukee Valve Company.

## 2.6 UNLISTED GENERAL-DUTY VALVES

- A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
- B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
- C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
- D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

## 2.7 SPECIALTY VALVES

- A. Sprinkler System Control Valves: UL listed and FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
  - 1. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

- a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
- b. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

# 2.8 SPRINKLERS

- A. Sprinklers in reflective ceiling tile to be white concealed sprinklers.
- B. Sprinklers in drywall ceiling tile to be white concealed sprinklers.
- C. Sprinklers exposed to view to be brass upright or pendent.
- D. Sprinklers in Mercantile and Ordinary Hazard areas to be white, concealer sprinklers, 8.0 orifice UL/FMG approved.
  - 1. Manufacturers
    - a. Reliable Automatic Sprinkler Co., Inc.
    - b. Viking.
    - c. TYCO.
    - d. Victaulic Co. of America.

# 2.9 FIRE DEPARTMENT CONNECTIONS

- A. Yard Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlet, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA requirements and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
  - 1. Type: Free Standing, with two inlets.
  - 2. Finish: Brass.

## 2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm: UL 464, with 10-inch- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
- C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

- D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
- E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

## 2.11 PRESSURE GAGES

- A. Manufacturers:
  - 1. AMETEK, Inc.; U.S. Gauge.
  - 2. Dresser Equipment Group; Instrument Div.
  - 3. WIKA Instrument Corporation.
- B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 300 psig.
  - 1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
  - 2. Air System Piping: Include caption "AIR" or "AIR/WATER" on dial face.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.

#### 3.2 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

#### 3.3 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.4 PIPING APPLICATIONS, GENERAL

- A. Shop weld pipe joints where welded piping is indicated.
- B. Do not use welded joints for galvanized-steel pipe.
- C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with and threaded grooved-end fittings; joints.

## 3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
  - 1. NPS 2 and Smaller: Threaded-end, black or galvanized, standard weight steel pipe; castor malleable-iron threaded fittings; and threaded joints.
  - 2. NPS 2-1/2 and Larger: Grooved, Schedule 10 steel pipe; grooved fittings; and grooved joints.
  - 3. Threadable thinwall and Schedule 5 and Schedule 7 pipe shall not be utilized.

# 3.6 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 20.
    - a. Shutoff Duty: Use ball, butterfly, or gate valves.
  - 2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 20.
    - a. Shutoff Duty: Use ball, butterfly, or gate valves.
    - b. Throttling Duty: Use ball or globe valves.

#### 3.7 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40.
- C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

- 1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
- 2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
- D. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
  - 1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
  - 2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
  - 3. NPS 5 and Larger: Use dielectric flange insulation kits.

# 3.8 WATER-SUPPLY CONNECTION

- A. Connect fire-suppression piping to building's interior water distribution piping at a point 12" AFF inside the building. Refer to Division 22 Section "Domestic Water Piping" for interior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water distribution piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.
- D. Fire sprinkler contractor shall be required to install and test the FDC to the exterior location.

## 3.9 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- E. Install sprinkler piping with drains for complete system drainage.
- F. Install drain valves on standpipes.
- G. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

#### WATER-BASED FIRE-SUPPRESSION SYSTEMS

- H. Install alarm devices in piping systems.
- I. Hangers and Supports: Comply with NFPA 13 for hanger materials.
  - 1. Install sprinkler system piping according to NFPA 13 and Factory Mutual guidelines.
- J. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- K. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- L. Fill wet-pipe sprinkler system piping with water.

## 3.10 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 20 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Valves for Wall-Type Fire Hydrants: Install non rising-stem gate valve in water-supply pipe.
- D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
- E. Specialty Valves:
  - 1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

# 3.11 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install pedestal -type, fire department connections as shown on the drawing.
- B. Install freestanding-type, fire department connections in level surface.
  - 1. Install protective pipe bollards on two sides of each fire department connection. Refer to Division 05 Section "Metal Fabrications" for pipe bollards.
- C. Install ball drip valve at the check valve for fire department connection.

## 3.12 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Electrical Connections: Power wiring is specified in Division 26.
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- I. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.13 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 20.

#### 3.14 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Energize circuits to electrical equipment and devices.
  - 4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  - 5. Coordinate with fire alarm tests.
  - 6. Coordinate with fire-pump tests.
  - 7. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.
# 3.15 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

# 3.16 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 211000

# SECTION 220010 – GENERAL REQUIREMENTS

PART 1 - GENERAL

## 1.1 CONDITIONS

A. The General Conditions, Supplementary General Conditions and Division 1 General Requirements apply to Division 23.

### 1.2 SUMMARY OF WORK

- A. The work to be done under this Specification and the accompanying drawings includes the furnishing of labor, materials, equipment and services necessary for the proper completion of plumbing work
- B. The omission of express reference to any parts necessary for or reasonably incidental to a complete installation shall not be construed as releasing the contractor from furnishing such parts.
- C. All work shall be performed in a clean and workmanlike manner. Care shall be exercised to minimize any inconvenience or disturbance to other areas of the building which are to remain in operation. Isolate work areas by means of temporary partitions and/or tarps to keep dust and dirt with construction area.
- D. No equipment, etc. shall be removed, disconnected, or shut down without prior review with the Owner and/or Engineer to confirm that areas to remain in operation will not be affected. If any areas not within the scope of work are affected by any shutdown, removal, or disconnection, sufficient advance notice must be given to the Owner indicating which areas will be affected, when the proposed shutdown will occur, and for how long a period of time.
- E. All items indicated to be demolished or removed shall become property of the contractor and shall be disposed of off-site unless indicated otherwise.
- F. Contractor shall field verify all dimensions and existing conditions prior to proceeding with any work. Where discrepancies occur between these documents and existing conditions, the discrepancy shall be reported to the Owner and/or Engineer for expediting and resolution.
- G. Clean the job site daily and remove from the premises any dirt and debris caused by the performance of the work included in this contract.
- H. Use of the Owner's elevators and building corridors for handling of the removed equipment and materials shall be at the direction of the Owner and shall be coordinated with his operations.
- I. The Contractor shall be responsible for the safekeeping of his own property on the job site. Owner assumes no responsibility for protection of properties against fire, theft, and environmental conditions.
- J. Where used, the term "Provide" shall mean "Furnish and Install."

- K. The Contractor shall coordinate his work with all other trades.
- L. Contractor to provide for final connections to equipment, including Owner-provided equipment.

# 1.3 INSPECTION OF SITE

- A. Before submitting a proposal on the work contemplated in this Specification and accompanying drawings, each bidder shall examine the site and check as to the means of making connections to services and shall familiarize himself with the existing conditions and limitations. No extras will be allowed because of the contractor's misunderstanding as to the amount of work involved or lack of knowledge of any site conditions which may affect the work. Any apparent variance of the plan or specification from the existing conditions at the site shall be called to the attention of the Engineer during the bid period so clarification can be made by addendum.
- B. The existence of any wires, conduits, pipes, ducts, or other facilities are shown in a general way only. It will be the duty of the bidding contractors to visit the site and make exact determination of the existence of such facilities prior to the submission of bids. It is understood that the bidders will be responsible for making the exact determination of the location and condition of such facilities.

## 1.4 FEES, PERMITS, TAXES, AND INSPECTIONS

- A. Regular inspections shall be requested by the contractor as required by regulations. Charges for the inspections by regulating agencies of installations or plans and specifications shall be paid by the contractor.
- B. All permits, inspections and licenses shall be secured and paid for before actual work is started.
- C. The contractor, after completion of work, shall furnish to the Owner a Certificate of Final Inspection and approval from the inspection bureau having jurisdiction.
- D. State and Local Sales Tax. The Plumbing Contractor shall include all state and local sales tax in the bid. The contractor shall maintain accurate records of all taxes and furnish such records to the Owner upon request.

## 1.5 CODES AND STANDARDS

- A. Contractor shall comply with all current ordinances, laws, regulations and codes applicable to the work involved. This does not relieve the contractor from furnishing and installing work shown or specified which may be beyond the requirement of such ordinances, laws, regulations and codes.
- B. In case of difference between building codes, specifications, state laws, local ordinances, industry standards, and utility company regulations and the Contract Documents, the most stringent shall govern. The contractor shall promptly notify the Engineer in writing of such difference.

- C. Non-Compliance: Should the contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards and utility company regulations, he shall bear all costs arising in correcting the deficiencies.
- D. Contractor shall initiate, maintain, and supervise all safety pre-cautions required for his work including regulations of the Occupational Safety and Health Administration (OSHA).
- E. UL Compliance. All equipment and systems specified in Division 23 shall comply with all applicable UL safety standards and have all required UL listings. All systems shall have UL-listed components, as well as a UL listing for the entire system. When a UL listing for the system is not available, the system shall be tested by an independent laboratory or certified by an impartial licensed professional engineer per Indiana Statutes.

## 1.6 DRAWINGS

- A. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed.
- B. The drawings are to scale as noted but the contractor shall refer to Architectural and structural Drawings for exact location of partitions, walls, beams, shafts, equipment, etc.
- C. Each trade shall avail himself of drawings and specifications of all other trades and make an effort to coordinate his work with all other trades.
- D. The contractor, before roughing-in facilities or installation of any equipment, shall consult all drawings, architectural, structural, plumbing, etc. for finishes, locations of ceiling, ceiling types, structural members, pipes, ducts, recessed lighting fixtures, conduits, etc., which may affect the installation. The contractor in installing his equipment shall leave adequate room for the installation of equipment by other contractors or subcontractors where space is limited.
  - 1. Consideration has been given to such condition of limited space in the preparation of the drawings and the locations and dimensions of equipment have been selected accordingly. The contractor shall be warned that in certain instances, space may be limited to the extent that there may be only one arrangement of equipment or facilities which will allow installation of same.
  - 2. Where connections are made to equipment furnished by others, the contractor shall obtain exact location of connection from persons furnishing that equipment. The contractor shall confirm all voltage, circuit breaker, and wiring requirements prior to installation.
- E. Discrepancies discovered before or after work has started, shall be brought to the attention of the Engineer immediately and the Engineer reserves the right to require minor changes in the work to eliminate such discrepancies with no change in contract cost.
- F. The plans and specifications are complementary and what is called for in either one shall be as binding as if called for in both.
- G. Where a disagreement exists in the plans and specifications, the item or arrangement of better quality, greater quantity or higher cost, shall be included.

### 1.7 CAD DRAWING FILES

- A. All Division 23 electronic CAD drawing files provided by the Architect/Engineer for this project are for use solely with respect to this project. The Plumbing Contractor may request copies of the Division 23 CAD drawing files for the preparation of shop drawings. However, CAD drawing files shall not be used on other projects, for additions to this project, or for completion of this project by others. Any intentional or unintentional revisions, additions, or deletions to these Division 23 CAD drawing files shall be made at eh full risk of the person(s) making such revisions, additions, or deletions, and such person(s) shall hold harmless and indemnify Architect/Engineer of any and all responsibilities and liabilities.
- B. The CAD files are not to be construed as updated as-built construction documents. The drawing files reflect only bidding documentation of original Construction Drawings. Addenda or written changes occurring during the construction process will not be incorporated into the Division 23 CAD drawing files.
- C. CAD files will be furnished to the Plumbing Contractor at the sole discretion of the Engineer.

### 1.8 SYMBOLS AND ABBREVIATIONS

A. Refer to Symbols and Abbreviations listed on drawings. Other symbols are in common usage but if uncertainty exists regarding plan symbols or abbreviations they shall be brought to the attention of the Engineer for clarification.

### 1.9 PRIOR APPROVALS

A. Refer to Section 01 60 00 - Product Requirements for submittal procedures of equivalent products.

#### 1.10 COORDINATION

- A. Coordinate work with other trades in the installation of equipment, piping, conduit, and ductwork.
- B. Refer to Section 01 31 00 Project Management and Coordination for requirements.
- C. Contractors shall solve all coordination conflicts among themselves when possible. The Engineer will arbitrate when necessary, and his judgment will stand, with no additional cost to the owner.
- D. For equipment requiring connections by other contractors, provide Architect approved submittals to the appropriate contractors. Approved submittals are to depict the required connections.
- E. All shop drawings shall be sent to all appropriate contractors for coordination prior to fabrication.

### 1.11 TEMPORARY SERVICES

A. The Plumbing Contractor shall carefully examine all parts of the General Requirements for requirements regarding temporary water, sanitary, and other services. Contractor shall include in his bid an amount to cover his portion of such services.

# PART 2 - PRODUCTS

## 2.1 FIRE BARRIER SEALING SYSTEM

A. This contractor shall furnish all labor and materials needed to preserve the fire, smoke, and water containment integrity of the fire rated floors, walls and ceilings penetrated by ductwork, piping, or conduit. Refer to Section 07 84 13 - Penetration Firestopping.

### 2.2 SPARE PARTS

A. Provide products, spare parts, and maintenance materials as specified in other sections of the Project Manual. Refer to Division 1.

## PART 3 - EXECUTION

### 3.1 CUTTING AND PATCHING

- A. This contractor shall perform all cutting and patching necessary in order to perform this work unless noted on drawings to be performed by the General Contractor - however, special permission shall be obtained from the engineer before cutting structural members or finished material. Patching shall be performed in such a manner as to leave no visible trace and to return the part affected to the condition of undisturbed work. Patching work shall be performed by workers experienced, skilled, and licensed for the particular type of work involved. Inferior work will not be accepted. Holes in masonry shall be drilled in rotary drills. Impact tools shall not be used.
- B. Prevent the spread of dust, debris and other material into adjacent areas.

#### 3.2 DEMOLITION

A. Disconnect and remove items noted and as directed. Each Contractor is responsible to remove all equipment, materials, and accessories associated with removed items (insulation, hanger, etc.) under his Contract under the provisions of Division 0.

# 3.3 HOLES THROUGH MASONRY

- A. The Plumbing Contractor shall provide all holes and openings required for plumbing work.
- B. Holes made in existing masonry for plumbing equipment shall be core drilled.

- C. The contractor shall be responsible for grouting air-tight any openings adjacent to raceways etc. to seal against passage of air, smoke or vapors. Maintain ratings of fire rated partitions.
- D. The contractor shall be responsible for providing and disposing of water used in the core drilling operation. Work shall be scheduled and other trades coordinated so that damage will not result from the use of water.
- E. The contractor shall install in each wall and floor sleeve opening fire rated material to maintain the fire rating of partition or floor.
- F. Contractor shall maintain watertight construction.

## 3.4 FOUNDATIONS AND ANCHOR BOLTS

- A. Install all plumbing and motor-driven equipment and associated accessories on 4" high reinforced concrete foundations, unless otherwise specified or noted on Drawings. Extend foundation to support vibration isolation equipment where required.
- B. Foundation to be provided and installed by the General Contractor under provisions of Section 03 30 00.
- C. Provide General Contractor with exact location and dimensions of foundations.
- D. Where the equipment to be installed requires anchor bolts, bolts shall be set to template as the foundations are formed.
- E. 45-degree chamfer corners and edges of foundations by moldings placed in the forms.
- F. Smooth exposed portions of foundations which are rough after removing forms with a mixture of one part cement to two parts sand.

## 3.5 WALL CHASES AND RECESSES

- A. Supervise the construction of chases and recesses in walls for plumbing systems.
- B. Provide the necessary information for the proper size and location to the Masonry Contractor in a timely manner.

## 3.6 CONCRETE BASES AND PADS

A. Concrete bases and pads for plumbing equipment shall be provided by the plumbing contractor. Provide concrete pads for all floor mounted and exterior grade mounted plumbing equipment.

# 3.7 ELECTRICAL CONNECTIONS TO EQUIPMENT

A. Electrical circuits, conduit, raceways, wiring and connections to devices and equipment furnished under Division 23 that are not depicted on the Electrical Drawings or indicated in

Division 26 and 28 specifications are the responsibility of the Contractor providing the equipment.

B. Plumbing contractor to coordinate plumbing equipment breaker sizes with electrical contractor prior to ordering.

# 3.8 CHANGING OUTLETS

A. When necessary to fit and center with tile, plaster, paneling and other coverings of the wall, floor or ceiling space, shift the equipment, pipe, or other outlet, as directed by the Architect/Engineer.

## 3.9 RECORD DRAWING NOTES

- A. Contractor shall clearly mark up a set of prints in red to show installed equipment, material and conditions that vary from the original. A complete set of drawings shall be kept at job site at all times upon which each field change shall be marked including all depths, dimensioned locations, sizes, etc. See Division 1.
- B. As work progresses, the contractor shall record all changes and deviations from the Contract Drawings. Refer to Division 1 for specific requirements. Include the following as a minimum:
  - 1. Record exact location and elevation of underground conduits, duct banks and direct burial wiring.
  - 2. Prepare Record Drawing changes for all plumbing work within the building that occurs during the progress of construction. Include such changes as:
    - a. Addenda
    - b. Change orders
    - c. Relocation of devices during construction
    - d. Routing of piping.
    - e. Final locations of equipment.
    - f. Value engineering.
- C. The Record Drawings shall be maintained at the job site and be subject to review by the owner or architect/engineer during the construction period. This record keeping requirement shall not be construed as authorization for the contractor to make changes in the layout without definite instructions by the architect/engineer in each case.
- D. Upon completion of the job, submit scan copy of Project Record Drawings.

## 3.10 OPERATING AND MAINTENANCE MANUAL(S)

- A. Refer to Section 01 78 23 Operation and Maintenance Data for general requirements.
- B. Cross out or delete all information shown on Shop Drawings and other literature definitely not applying to this particular project and its equipment installed.

C. Manuals that do not meet the foregoing criteria will be rejected and returned to the contractor for resubmittal.

## 3.11 FINAL OBSERVATION

A. A final observation of the plumbing systems by the Architect/Engineer will be conducted before the contract can be considered complete. The contractor shall inform the Engineer in writing when the plumbing installation is complete and ready for final observation. The Engineer shall visit the project and provide a list of items that need to be corrected or completed to achieve final completion. Should the Engineer attend the project to conduct the final observation and discovers that the work is not sufficiently complete to perform this task, then the contractor shall compensate the Engineer for his time. The contractor shall remain responsible for completing his work and requesting the Engineer to return for a final observation.

### 3.12 TESTS

- A. The contractor shall test the equipment installed under this specification and shall demonstrate its proper operation to the engineer when requested by the engineer.
- B. No equipment shall be tested, or operated for any purpose until it has been fully prepared, connected and made ready for normal operation. Damage to equipment occasioned by improper or ill-timed operation or testing shall be made good, at the contractor's expense, before final inspection and acceptance.

#### 3.13 TRAINING

A. Refer to Section 01 79 00 - Demonstration and Training for general requirements.

## 3.14 MATERIAL AND WORKMANSHIP

- A. All material and workmanship must be of the best throughout. Material and equipment must be new and must be adequately protected from damage and dirt. Each item or system shall be listed, inspected, and approved by a nationally recognized testing laboratory and shall bear a label indicating such. The Engineer reserves the right to reject material or workmanship not in accordance with the Specifications, either before or after installation. Contractor will be held responsible for defects in the material and workmanship which may appear during guarantee period after the building has been accepted. Such defects must be repaired or defective material replaced by the contractor at no expense to the owner.
- B. No asbestos, hazardous, or PCB containing materials of any type shall be used on this project.
- C. The contractor shall be responsible for the proper installation of all systems in this contract and shall guarantee to remedy free of charge any defects in workmanship and materials for a period of 12 months from substantial completion.

## 3.15 FIRE RATED CEILINGS

- A. All enclosures shall be of sufficient size and depth to permit proper mounting and operation of equipment. Verify requirements with equipment manufacturer.
- B. Refer to Architectural drawings for locations of fire rated ceilings.

# 3.16 FINAL NAMES AND NUMBERS FOR ROOMS AND DOORS

A. Contractor shall note that names and numbers of rooms and doors on the architectural plans may not be the same as that selected by the owner for use in their final naming and/or numbering scheme. Contractor shall use final room names and numbering system as directed by the owner. This shall apply to all labeling, identification, and programming that is required by the Division 23 drawings and specifications.

END OF SECTION 220010

# SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

# PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Sleeves.
  - 5. Escutcheons.
  - 6. Grout.
  - 7. Temporary water service during construction.
  - 8. Equipment installation requirements common to equipment sections.
  - 9. Concrete bases.
  - 10. Supports and anchorages.
- B. Related Sections:
  - 1. Division 01 Section Project Management and Coordination for requirements related to each sub contractor's responsibility to complete coordination drawings and submit.
  - 2. Division 01 78 39 Section Project Record Documents for requirements related to each sub contractor's responsibility to submit record drawing to the owner as part of the operation and maintenance data (section 017823).
  - 3. Division 230500-1.3 coordination.

#### 1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

## 1.3 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## 1.4 WARRANTY

A. Provide (1) year parts and labor, (5) year for compressors unless otherwise noted.

# PART 2 - PRODUCTS

# 2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

## 2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.

- G. Solvent Cements for Joining Plastic Piping:
  - 1. ABS Piping: ASTM D 2235.
  - 2. CPVC Piping: ASTM F 493.
  - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - 4. PVC to ABS Piping Transition: ASTM D 3138.

## 2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solderjoint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

# 2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Plastic Carbon steel Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated and rough brass.

### 2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 TEMPORARY WATER SERVICE

- A. Provide a metered, domestic water connection for site use following the installation of the water main.
- B. Repair leaks for a water tight installation.
- C. Protect water service from freezing conditions using electrical heat tape or other means.

- D. Install at least one valved hose connection for use by all personnel on site.
- E. Comply with municipal requirements regarding water service and usage.

# 3.2 PIPING SYSTEMS – COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- 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 otherwise.
- 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. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Verify final equipment locations for roughing-in.
- M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

## 3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assem-

bly.

- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

# 3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect pip-

ing materials of dissimilar metals.

# 3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

## 3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

## 3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

# 3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor

plumbing materials and equipment.

- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

# 3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

## 3.10 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.11 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.

- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
  - 1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE.
  - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
    - a. Extend sleeves 2 inches above finished floor level.
    - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."
  - 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
    - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
    - b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
    - c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
  - 4. Sleeves for Piping Passing through Concrete Roof Slabs: Galvanized-steel pipe.
  - 5. Sleeves for Piping Passing through Exterior Concrete Walls:
    - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
    - b. Cast-iron wall-pipe sleeves for pipes NPS 6 and larger.
    - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
  - 6. Sleeves for Piping Passing through Interior Concrete Walls:
    - a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.
    - b. Galvanized-steel-sheet sleeves for pipes NPS 6 and larger.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors

at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

### 3.12 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
  - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
  - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
  - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
  - 4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chromeplated finish.
  - 5. Bare Piping in Equipment Rooms: One piece, cast brass.
  - 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

END OF SECTION 220500

# SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

# PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Brass ball valves.
  - 2. Bronze ball valves.
  - 3. Iron, single-flange butterfly valves.
  - 4. Bronze swing check valves.
  - 5. Iron swing check valves.
  - 6. Iron swing check valves with closure control.
  - 7. Bronze gate valves.
  - 8. Iron gate valves.
  - 9. Bronze globe valves.
  - 10. Iron globe valves.
  - 11. Chainwheels.
- B. Related Sections:
  - 1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
  - 2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.
  - 3. Section 221319 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.
  - 4. Section 221423 "Storm Drainage Piping Specialties" for valves applicable only to this piping.

### 1.2 QUALITY ASSURANCE

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.
- C. All valves to be certified lead free.

## 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  - 1. Product data.

# PART 2 - PRODUCTS

# 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
  - 2. Handwheel: For valves other than quarter-turn types.
  - 3. Handlever: For quarter-turn valves NPS 6 and smaller.
  - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
  - 1. Gate Valves: With rising stem.
  - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Solder Joint: With sockets according to ASME B16.18.
  - 3. Threaded: With threads according to ASME B1.20.1.

# 2.2 BRASS BALL VALVES

- A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
    - d. Hammond Valve.
    - e. Kitz Corporation.
    - f. Milwaukee Valve Company.
    - g. NIBCO INC.
    - h. Red-White Valve Corporation.
  - 2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

# 2.3 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. American Valve, Inc.
    - b. Conbraco Industries, Inc.; Apollo Valves.
    - c. Crane Co.; Crane Valve Group; Crane Valves.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Red-White Valve Corporation.
    - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 150 psig.
    - c. CWP Rating: 600 psig.
    - d. Body Design: Two piece.
    - e. Body Material: Bronze.
    - f. Ends: Threaded.
    - g. Seats: PTFE or TFE.
    - h. Stem: Bronze.
    - i. Ball: Chrome-plated brass.
    - j. Port: Full.

# 2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
    - b. Conbraco Industries, Inc.; Apollo Valves.

- c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Crane Co.; Crane Valve Group; Stockham Division.
- f. DeZurik Water Controls.
- g. Flo Fab Inc.
- h. Hammond Valve.
- i. Kitz Corporation.
- j. Milwaukee Valve Company.
- k. NIBCO INC.
- 1. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
  - a. Standard: MSS SP-67, Type I.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
  - e. Seat: EPDM.
  - f. Stem: One- or two-piece stainless steel.
  - g. Disc: Aluminum bronze.
- B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
    - b. Conbraco Industries, Inc.; Apollo Valves.
    - c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
    - d. Crane Co.; Crane Valve Group; Jenkins Valves.
    - e. Crane Co.; Crane Valve Group; Stockham Division.
    - f. DeZurik Water Controls.
    - g. Flo Fab Inc.
    - h. Hammond Valve.
    - i. Kitz Corporation.
    - j. Milwaukee Valve Company.
    - k. NIBCO INC.
    - 1. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-67, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    - e. Seat: NBR.
    - f. Stem: One- or two-piece stainless steel.
    - g. Disc: Aluminum bronze.

# 2.5 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. American Valve, Inc.
    - b. Crane Co.; Crane Valve Group; Crane Valves.
    - c. Crane Co.; Crane Valve Group; Jenkins Valves.
    - d. Crane Co.; Crane Valve Group; Stockham Division.
    - e. Hammond Valve.
    - f. Kitz Corporation.
    - g. Milwaukee Valve Company.
    - h. NIBCO INC.
    - i. Powell Valves.
    - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 3.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B 62, bronze.
    - e. Ends: Threaded.
    - f. Disc: Bronze.

## 2.6 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements)::
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Kitz Corporation.
    - f. Milwaukee Valve Company.
    - g. NIBCO INC.
    - h. Powell Valves.
    - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-71, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Clear or full waterway.

- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

# 2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. NIBCO INC.
  - 2. Description:
    - a. Standard: MSS SP-71, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Clear or full waterway.
    - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - e. Ends: Flanged.
    - f. Trim: Bronze.
    - g. Gasket: Asbestos free.
    - h. Closure Control: Factory-installed, exterior lever and spring.
- B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-71, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Clear or full waterway.
    - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - e. Ends: Flanged.
    - f. Trim: Bronze.
    - g. Gasket: Asbestos free.
    - h. Closure Control: Factory-installed, exterior lever and weight.

## 2.8 BRONZE GATE VALVES

- A. Class 125, NRS Bronze Gate Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements)::
    - a. American Valve, Inc.
    - b. Crane Co.; Crane Valve Group; Crane Valves.
    - c. Crane Co.; Crane Valve Group; Jenkins Valves.
    - d. Crane Co.; Crane Valve Group; Stockham Division.
    - e. Hammond Valve.
    - f. Kitz Corporation.
    - g. Milwaukee Valve Company.
    - h. NIBCO INC.
    - i. Powell Valves.
    - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 1.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    - d. Ends: Threaded or solder joint.
    - e. Stem: Bronze.
    - f. Disc: Solid wedge; bronze.
    - g. Packing: Asbestos free.
    - h. Handwheel: Malleable iron, bronze, or aluminum.
- B. Class 125, RS Bronze Gate Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. American Valve, Inc.
    - b. Crane Co.; Crane Valve Group; Crane Valves.
    - c. Crane Co.; Crane Valve Group; Jenkins Valves.
    - d. Crane Co.; Crane Valve Group; Stockham Division.
    - e. Hammond Valve.
    - f. Kitz Corporation.
    - g. Milwaukee Valve Company.
    - h. NIBCO INC.
    - i. Powell Valves.
    - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - k. Zy-Tech Global Industries, Inc.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 2.
    - b. CWP Rating: 200 psig.

- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

# 2.9 IRON GATE VALVES

- A. Class 125, NRS, Iron Gate Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Flo Fab Inc.
    - e. Hammond Valve.
    - f. Kitz Corporation.
    - g. Milwaukee Valve Company.
    - h. NIBCO INC.
    - i. Powell Valves.
    - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-70, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - d. Ends: Flanged.
    - e. Trim: Bronze.
    - f. Disc: Solid wedge.
    - g. Packing and Gasket: Asbestos free.
- B. Class 125, OS&Y, Iron Gate Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements)::
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Flo Fab Inc.
    - e. Hammond Valve.
    - f. Kitz Corporation.
    - g. Milwaukee Valve Company.
    - h. NIBCO INC.
    - i. Powell Valves.
    - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

- 2. Description:
  - a. Standard: MSS SP-70, Type I.
  - b. CWP Rating: 200 psig
  - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - d. Ends: Flanged.
  - e. Trim: Bronze.
  - f. Disc: Solid wedge.
  - g. Packing and Gasket: Asbestos free.

# 2.10 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
  - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
  - 2. Attachment: For connection to butterfly valve stems.
  - 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
  - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

# PART 3 - EXECUTION

# 3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor.
  - 1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

# 3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

# 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

#### GENERAL-DUTY VALVES FOR PLUMBING PIPING

- 1. Shutoff Service: Ball, or butterfly valves.
- 2. Throttling Service: Ball, or butterfly valves.
- 3. Pump-Discharge Check Valves:
  - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
  - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
  - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valveend option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

# 3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze and brass: May be provided with solder-joint ends instead of threaded ends.
  - 2. Ball Valves: Two piece, full port, bronze with bonze and brass trim.
  - 3. Bronze Swing Check Valves: bronze.
- B. Pipe NPS 2-1/2 and Larger:
  - 1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
  - 2. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
  - 3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.

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. Thermal-hanger shield inserts.
  - 4. Fastener systems.
  - 5. Pipe positioning systems.
  - 6. Equipment supports.

### 1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for plumbing 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 capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

# PART 2 - PRODUCTS

## 2.1 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. Coatings, where designated:
    - a. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
    - b. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  - 3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

## 2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, 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.

# 2.3 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- 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.

## 2.4 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.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

# 2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

## 2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbonsteel shapes.
- 2.7 MISCELLANEOUS MATERIALS
  - A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galva-

nized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

# PART 3 - EXECUTION

## 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. 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.
- E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- 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 above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weightdistribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
  - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
  - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

#### 3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

## 3.3 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.

## 3.4 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: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 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 and metal trapeze pipe hangers and attachments for general service applications.
- F. Use padded hangers for piping that is subject to scratching.
- 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 NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steelpipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  - 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- 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 NPS 3/4 to NPS 24.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- 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.
- 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 barjoist 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. 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 or wooden beams.
- 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 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-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  - 3. 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.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- P. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

## END OF SECTION 220529

# SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

# 1.1 SECTION REQUIREMENTS

- A. Submittals:
  - 1. Product Data: For each product indicated.
  - 2. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 3. Welding certificates.

#### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: E.
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
    - a. Component Importance Factor: To be determined from ASCE 07-10, Section 13.1.1 for each component type.
    - b. Component Response Modification Factor: To be determined from ASCE 07-10, Table 13.6-1 for each component type.
    - c. Component Amplification Factor: To be determined from ASCE 07-10, Table 13.6-1 for each component type.
  - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): S\_DS = 0.437g (43.7%).
  - 4. Design Spectral Response Acceleration at 1-Second Period:  $S_D1 = 0.233g (23.3\%)$ .

#### 2.2 VIBRATION ISOLATORS

- A. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
  - 1. Resilient Material: Oil- and water-resistant neoprene.

- B. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
  - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridgebearing neoprene as defined by AASHTO.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
  - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
  - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- E. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
  - 1. 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.
  - 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. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  - 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

# 2.3 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

- 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with 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; and rated in tension, compression, and torsion forces.
- C. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- 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. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- F. Mechanical Anchor Bolts: 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 required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

# PART 3 - EXECUTION

## 3.1 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches.
  - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. 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.

## G. Drilled-in 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 the 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 Anchors: 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
- 5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

# 3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.

## 3.3 ADJUSTING

- A. Adjust isolators after piping 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 active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

## END OF SECTION 220548

# SECTION 220553 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Pipe labels.

## PART 2 - PRODUCTS

#### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 4. Fasteners: Stainless-steel rivets or self-tapping screws.
  - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
  - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
  - 2. Letter Color: Black.
  - 3. Background Color: White.
  - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
  - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

## 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.
- C. Coordinate installation of identifying devices with locations of access panels and doors.

## 3.3 PIPE LABEL INSTALLATION

- A. 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. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment. Radon vent piping reduce intervals to 10 feet.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels. B.
- B. Pipe Label Color Schedule:
  - 1. Domestic Water Piping:
    - a. Background Color: White.
    - b. Letter Color: Black.
  - 2. Sanitary Waste, Vent and Storm Drainage Piping:
    - a. Background Color: White.
    - b. Letter Color: Green.
  - 3. Fire Protection
    - a. Background Color: White.
    - b. Letter Color: Red.
  - 4. Gas Piping:
    - a. Background Color: White.
    - b. Letter Color: Green.
  - 5. Radon Vent Piping "radon reduction system"
    - a. Background Color: White
    - b. Letter Color: Yellow

## END OF SECTION 220553

# SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

#### 1.1 SECTION REQUIREMENTS

- A. Submittals:
  - 1. Product Data: For each type of product indicated.
  - 2. For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

## PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less according to ASTM E 84.
- B. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less according to ASTM E 84.

#### 2.2 INSULATION MATERIALS

- A. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- B. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- C. Mineral-Fiber Blanket Insulation: Comply with ASTM C 553, Type II and ASTM C 1290, Type I.
- D. Mineral-Fiber, Preformed Pipe Insulation: Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ.
- E. Mineral-Fiber, Pipe and Tank Insulation: Complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB; and having factory-applied ASJ. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.
- F. Polyolefin Insulation: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

## 2.3 ADHESIVES

- A. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less.

## 2.4 MASTICS

- A. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- B. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 3. Solids Content: 60 percent by volume and 66 percent by weight.
  - 4. Color: White.

# 2.5 SEALANTS

- A. Joint Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Permanently flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
  - 4. Color: White or gray.
  - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less.
- B. ASJ Flashing Sealants:
  - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 2. Fire- and water-resistant, flexible, elastomeric sealant.
  - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 4. Color: White.
  - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less.

#### 2.6 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 C 1136, Type I.
  - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## 2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 11.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 1. Width: 3 inches.
  - 2. Thickness: 6.5 mils.
  - 3. Adhesion: 90 ounces force/inch in width.
  - 4. Elongation: 2 percent.
  - 5. Tensile Strength: 40 lbf/inch in width.
  - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

# PART 3 - EXECUTION

## 3.1 PIPE INSULATION INSTALLATION

- A. Comply with requirements of the Midwest Insulation Contractors Association's "National Commercial & Industrial Insulation Standards" for insulation installation on pipes and equipment.
- 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, Partition, and Floor Penetrations: Install insulation continuously through penetrations. Seal penetrations. Comply with requirements in Section 078413 "Penetration Firestopping."

- D. Flexible Elastomeric Insulation Installation:
  - 1. Seal longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
  - 2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- E. Mineral-Fiber Insulation Installation:
  - 1. Insulation Installation on Straight Pipes and Tubes: Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - 2. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
  - 3. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- F. Polyolefin Insulation Installation:
  - 1. Seal split-tube longitudinal seams and end joints with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
  - 2. Insulation Installation on Pipe Fittings and Elbows: Install mitered sections of polyolefin pipe insulation. Secure insulation materials and seal seams with adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- G. Interior Piping System Applications: Insulate the following piping systems:
  - 1. Domestic hot water.
  - 2. Recirculated domestic hot water.
  - 3. Roof drain bodies and horizontal rainwater leaders of storm water piping.
  - 4. Exposed water supplies and sanitary drains of fixtures for people with disabilities.
- H. Do not apply insulation to the following systems, materials, and equipment:
  - 1. Flexible connectors.
  - 2. Sanitary drainage and vent piping.
  - 3. Drainage piping located in crawlspaces unless otherwise indicated.
  - 4. Chrome-plated pipes and fittings, except for plumbing fixtures for people with disabilities.
  - 5. Piping specialties, including air chambers, unions, strainers, check valves, plug valves, and flow regulators.

## 3.2 INDOOR PIPING INSULATION SCHEDULE

- A. Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawlspaces.
  - 2. Underground piping.

- 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- B. Domestic Cold Water:
  - 1. **NPS 1** and Smaller: Insulation shall be one of the following:
    - a. Flexible Elastomeric: **1/2 inch** thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
    - c. Polyolefin: **1/2 inch** thick.
  - 2. **NPS 1-1/4** and Larger: Insulation shall be one of the following:
    - a. Flexible Elastomeric: **1 inch** thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch** thick.
    - c. Polyolefin: **1 inch** thick.
- C. Domestic Hot and Recirculated Hot Water:
  - 1. **NPS 1-1/4** and Smaller: Insulation shall be one of the following:
    - a. Flexible Elastomeric: **1 inch** thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch** thick.
    - c. Polyolefin: **1 inch** thick.
  - 2. **NPS 1-1/2** and Larger: Insulation shall be one of the following:
    - a. Flexible Elastomeric: **1 inch** thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch** thick.
    - c. Polyolefin: **1 inch** thick.
- D. Roof Drain and Overflow Drain Bodies:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: **1 inch** thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch** thick.
    - c. Polyolefin: **1 inch** thick.
- E. Exposed Sanitary Drains, Domestic Cold Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1/2 inch 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- F. Domestic hot-water storage tank and expansion tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
  - 1. Cellular glass.
  - 2. Mineral-Fiber Board: 3-lb/cu. ft. nominal density.

3. Mineral-fiber pipe and tank.

END OF SECTION 220700

# SECTION 221116 - DOMESTIC WATER PIPING

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
  - 2. Specialty valves.
  - 3. Transition fittings
  - 4. Dielectric fittings
  - 5. Flexible connectors.
  - 6. Water meter.
- B. Related Section:
  - 1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

#### 1.2 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.
- C. Comply with NSF 61 for potable domestic water piping and components.
- D. All piping shall be tested for working pressure of 150 psi minimum and temperature of 210 degree Fahrenheit, as required by Minnesota code.
- E. Water service line must be installed at least 10 feet horizontally from any manhole, catchbasin, or any other potential source of contamination (see Minnesota Rules, part 4715.1710, subpart 3).

#### PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

A. 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

#### 2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tubing: ANSI H23.1, ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Soft Copper Tube: ANSI H23.1, ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ANSI H23.1, ANSI B16.22, ANSI B1618, ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASTM B62, ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
  - 1. MSS SP-123.
  - 2. Cast-copper-alloy, hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal seating surfaces.
  - 4. Solder-joint or threaded ends.

# 2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe:
  - 1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 2. ANSI A21.15 compliant.
  - 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Standard-Pattern, Mechanical-Joint Fittings:
  - 1. AWWA C110/A21.10, ductile or gray iron.
  - 2. ANSI A21.15 compliant.
  - 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Compact-Pattern, Mechanical-Joint Fittings:
  - 1. AWWA C153/A21.53, ductile iron.
  - 2. ANSI A21.15 compliant.
  - 3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

# 2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

#### DOMESTIC WATER PIPING

- 1. ASTM A 53/A 53M, Type E, Grade B, Standard Weight.
- 2. Include ends matching joining method.
- B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
- C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Malleable-Iron Unions:
  - 1. ASME B16.39, Class 150.
  - 2. Hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal, bronze seating surface.
  - 4. Threaded ends.
- E. Flanges: ASME B16.1, Class 125, cast iron.
- 2.5 CPVC PIPING (building distribution system only)
  - A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40.
    - 1. CPVC Socket Fittings: ASTM F 438 for Schedule 40.
    - 2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
    - 3. Pipes 2-1/4inch to 6-inch in size must be schedule 80 and must also comply with ASTM Standard F441.
  - B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
  - C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.
  - D. CPVC piping and fittings shall also be compliant with ASTM Standard F441, ANSI 119.1, ANSI 119.2, NSF14, FHA bulletin #76 and CSA-B137.6
  - E. The installation of chlorinated polyvinyl chloride (CPVC) pipe for water distribution systems must meet the following requirements (see Minnesota Rules, part 4715.0520):
    - 1. Pipes less than 2 -inch in size must comply with ASTM Standard D2846.
    - 2. Pipes 2 -inch to 6-inch in size must be schedule 80 and must comply with ASTM Standard F441.
    - 3. Solvent weld joints must either include the use of a primer which is of contrasting color to the pipe and cement or a one-step solvent cement complying with ASTM Standard F493 and ASTM Standard D2846 (see Minnesota Rules, part 4715.0810, subpart 2).
    - 4. The installation must be in accordance with International Association of Plumbing and Mechanical Officials (IAPMO) installation Standards 20-98.
- 2.6 PEX TUBE AND FITTINGS (building distribution system only)
  - A. PEX Distribution System: ASTM F 877, SDR 9 tubing. System (tubing and fittings) shall be certified by independent third-party certifier.

- B. PEX Tube: ASMT F876, ASTM F877, NSF14 and NSF 61, with certification by independent third-party certifier.
- C. PEX Fittings: ASMT F1807, ASMT F1960, NSF14, NSF 61, ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.
- D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.
- E. PEX piping and fittings shall also be compliant with ASMT F876, ASTM F877, NSF14 and NSF61.
- F. This water distribution system shall be installed by a factory-trained installer in accordance with manufacturers installation instructions. Tubing and fittings must be marked with appropriate ASTM designations by manufacturer.

# 2.7 POLYPROPYLENE TUBE AND FITTINGS (PP-R) (building distribution system only)

- A. Manufacturers:
  - 1. Aquatherm, Inc. Greenpipe® with fusiolen®, Viega FostaPEX pureflow press system.
- B. Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in a three layer extrusion process. Domestic hot water shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.
- C. Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11. All return air plenum areas shall contain bronze (25/50 ASTM E84 compliant) fittings.
- D. Valves shall be manufactured in accordance with the manufacturers specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All return air plenum areas shall contain bronze (25/50 ASTM E84 compliant) valves.
- E. Where insulation is indicated on the drawings or in these specifications and where piping is located in a return air plenum, Aquatherm Advanced pipe with thermal (radiant, conductive, and convective) and vapor barrier insulation shall be provided. The thick wall, self insulating fittings do not require an additional vapor barrier for the piping system to meet this performance level. The thermal barrier is UV resistant, CFC-free, non-porous, non-fibrous, and resist mold growth. The pipe with the integral thermal barrier with standard unprotected fittings shall meet

the ASTM E84 and the CAN/ULC S102.2 requirements for a Flame Spread Rating of 25 and Smoke Development rating of 50.

F. Piping shall contain properties (Aquatherm fraser-composite pipe) to accommodate for linear thermal expansion. Piping shall be capable of a 75% reduction in expansion and contraction over standard PP-R piping.

## 2.8 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
  - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
  - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for generalduty brazing unless otherwise indicated.
- F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493 and ASTM Standard D2846.
  - 1. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.9 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
- C. CPVC Union Ball Valves:
  - 1. Description:
    - a. Standard: MSS SP-122.

- b. Pressure Rating: 125 psig at 73 deg F.
- c. Body Material: CPVC.
- d. Body Design: Union type.
- e. End Connections for Valves NPS 2 and Smaller: Detachable, socket.
- f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or Flanged.
- g. Ball: CPVC; full port.
- h. Seals: PTFE or EPDM-rubber O-rings.
- i. Handle: Tee shaped.
- D. CPVC Ball Check Valves:
  - 1. Description:
    - a. Pressure Rating: 125 psig at 73 deg F.
    - b. Body Material: CPVC.
    - c. Body Design: Union-type ball check.
    - d. End Connections for Valves NPS 2 and Smaller: Detachable, socket.
    - e. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or Flanged.
    - f. Ball: CPVC.
    - g. Seals: EPDM- or FKM-rubber O-rings.
- E. CPVC Gate Valves:
  - 1. Description:
    - a. Pressure Rating: 125 psig at 73 deg F.
    - b. Body Material: CPVC.
    - c. Body Design: Nonrising stem.
    - d. End Connections for Valves NPS 2 and Smaller: Socket.
    - e. End Connections for Valves NPS 2-1/2 to NPS 4: Socket or Flanged.
    - f. Gate and Stem: Plastic.
    - g. Seals: EPDM rubber.
    - h. Handle: Wheel.

## 2.10 TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.
  - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Charlotte Pipe and Foundry Company.

- b. Harvel Plastics, Inc.
- c. Spears Manufacturing Company.
- 2. Description:
  - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
  - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- D. Plastic-to-Metal Transition Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Colonial Engineering, Inc.
    - b. NIBCO Inc.
    - c. Spears Manufacturing Company.
  - 2. Description:
    - a. CPVC four-part union.
    - b. Brass or stainless-steel threaded end.
    - c. Solvent-cement-joint or threaded plastic end.
    - d. Rubber O-ring.
    - e. Union nut.

# 2.11 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
  - 1. Description:
    - a. Pressure Rating: 150 psig at 180 deg F.
    - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  - 1. Description:
    - a. Factory-fabricated, bolted, companion-flange assembly.
    - b. Pressure Rating: 150 psig.
    - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solderjoint copper alloy and threaded ferrous.
- D. Dielectric Couplings:
  - 1. Description:

- a. Galvanized-steel coupling.
- b. Pressure Rating: 300 psig at 225 deg F.
- c. End Connections: Female threaded.
- d. Lining: Inert and noncorrosive, thermoplastic.

## 2.12 FLEXIBLE CONNECTORS

- A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
  - 1. Working-Pressure Rating: Minimum 200 psig.
  - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
  - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
  - 1. Working-Pressure Rating: Minimum 200 psig.
  - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
  - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

## 2.13 WATER METERS

- A. Site water meter shall be provided per city/state requirements.
- B. Tenant sub-meter: Magnetic drive, low torque register measuring in gallons. Register to be magnet resistant and moisture resistant. Inline strainer. Pulse output contact closure to interface with wireless transmitter or remote metering device. Manufacturer: Norgas Singlemag Water Meter.

## PART 3 - EXECUTION

## 3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

## 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install domestic water piping level and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. 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.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- R. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- S. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."

- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."
  - W. Contractor shall provide new isolation valves at all new plumbing fixtures, and at all plumbing fixtures that have been relocated. New plumbing fixtures that are maintaining same location & same feed do not require new isolation valves.

## 3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
- H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

# 3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

## Vincennes University Green Activities Center Partial Renovations

- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
  - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
  - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

## 3.5 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

## 3.6 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 to NPS 6: Use dielectric flange kits.

# 3.7 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.
- C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

#### 3.8 WATER METER INSTALLATION

- A. Rough-in domestic and irrigation water piping, and install water meters according to utility company's requirements. This contractor shall coordinate with local city or utility and provide meters as required and is responsible for all associated costs.
- B. Install water meters according to AWWA M6, utility company's requirements.
- C. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

## 3.9 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
  - 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. 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.
  - 3. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters and/or as indicated in local code whatever is LESS:
  - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
  - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
  - 6. NPS 6: 10 feet with 5/8-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters and/or as indicated in local code whatever is LESS:
  - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  - 3. NPS 2: 10 feet with 3/8-inch rod.
  - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.

- 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
- 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
- 7. NPS 6: 12 feet with 3/4-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters and/or as indicated in local code whatever is LESS:
  - 1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
  - 2. NPS 1-1/4 to NPS 2 48 inches with 3/8-inch rod.
  - 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
  - 4. NPS 4 and NPS 5 : 48 inches with 5/8-inch rod.
  - 5. NPS 6: 48 inches with 3/4-inch rod.
  - 6. NPS 8: 48 inches with 7/8-inch rod.
- J. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger and/or as indicated in local code whatever is LESS.
- K. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters and/or as indicated in local code whatever is LESS:
  - 1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
- L. Install hangers for vertical PEX piping every 48 inches and/or as indicated in local code whatever is LESS.
- M. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

## 3.10 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
  - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.

4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

## 3.11 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

## 3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
  - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
  - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
  - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
  - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
  - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
  - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
  - 6. Prepare reports for tests and for corrective action required.

- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

## 3.13 ADJUSTING

- A. Perform the following adjustments before operation:
  - 1. Close drain valves, hydrants, and hose bibbs.
  - 2. Open shutoff valves to fully open position.
  - 3. Open throttling valves to proper setting.
  - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    - b. Adjust calibrated balancing valves to flows indicated.
  - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
  - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
  - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

## 3.14 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
  - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

## 3.15 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:
  - 1. Soft copper tube without joints.
- D. Under-building-slab, domestic water, building-service piping, NPS 4 and larger, shall be the following:
  - 1. Push-on-joint, ductile-iron pipe; standard- or compact- pattern push-on-joint fittings; and gasketed joints.
- E. Aboveground domestic water piping, NPS 2-1/2 and smaller, shall be the following:
  - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed or soldered joints.
  - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- F. Aboveground domestic water piping, NPS 3 to NPS 4, shall be the following:
  - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed or soldered joints.

END OF SECTION 221116

# SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes the following domestic water piping specialties:
  - 1. Vacuum breakers.
  - 2. Backflow preventers.
  - 3. Hose bibbs.
  - 4. Wall hydrants.
  - 5. Drain valves.
  - 6. Water hammer arresters.
- B. See Division 22 Section "Domestic Water Piping" for water meters.

#### 1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

#### 1.3 QUALITY ASSURANCE

- A. NSF Compliance:
  - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
  - 2. Comply with NSF 61, "Drinking Water System Components Health Effects; Sections 1 through 9."

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  - 1. Product data
  - 2. Product certificates
  - 3. Wiring Diagrams
  - 4. Test and Balance report
  - 5. Field quality-control reports.
  - 6. Warranty: Sample of special warranty.

## PART 2 - PRODUCTS

## 2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Ames Co.
    - b. Watts Industries, Inc.; Water Products Div.
    - c. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1001.
  - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
  - 4. Body: Bronze.
  - 5. Inlet and Outlet Connections: Threaded.
  - 6. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. MIFAB, Inc.
    - b. Watts Industries, Inc.; Water Products Div.
    - c. Woodford Manufacturing Company.
    - d. Zurn Plumbing Products Group; Wilkins Div.
  - 2. Standard: ASSE 1001.
  - 3. Body: Bronze, non-removable, with manual drain.
  - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
  - 5. Finish: Chrome or nickel plated.

## 2.2 BACKFLOW PREVENTERS

- A. Intermediate Atmospheric-Vent Backflow Preventers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Watts Industries, Inc.; Water Products Div.
    - b. Zurn Plumbing Products Group; Wilkins Div.
    - c. MIFAB
  - 2. Standard: ASSE 1012.
  - 3. Operation: Continuous-pressure applications.
  - 4. Size: NPS 1/2 or NPS 3/4.
  - 5. Body: Bronze.
  - 6. End Connections: Union, solder joint.
- 7. Finish: Rough bronze.
- B. Reduced-Pressure-Principle Backflow Preventers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Watts Industries, Inc.; Water Products Div.
    - b. Zurn Plumbing Products Group; Wilkins Div.
    - c. MIFAB
  - 2. Standard: ASSE 1013.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
  - 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
  - 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
  - 7. Configuration: Designed for horizontal, straight through or vertical flow.
  - 8. Accessories:
    - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
    - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
    - c. Provide full size hard copper drain line from unit to nearest floor drain.
- C. Backflow-Preventer Test Kits:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Watts Industries, Inc.; Water Products Div.
    - b. Zurn Plumbing Products Group; Wilkins Div.
    - c. MIFAB
  - 2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with testprocedure instructions.

# 2.3 HOSE BIBBS

A. Hose Bibbs: As scheduled on drawings.

### 2.4 WALL HYDRANTS

- A. Wall hydrants: As scheduled on drawings.
- 2.5 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
  - 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
  - 2. Pressure Rating: 400-psig minimum CWP.
  - 3. Size: NPS 3/4.
  - 4. Body: Copper alloy.
  - 5. Ball: Chrome-plated brass.
  - 6. Seats and Seals: Replaceable.
  - 7. Handle: Vinyl-covered steel.
  - 8. Inlet: Threaded or solder joint.
  - 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

### 2.6 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Josam Company.
    - b. MIFAB, Inc.
    - c. Sioux Chief Manufacturing Company, Inc.
    - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - e. Watts Drainage Products Inc.
    - f. Zurn Plumbing Products Group; Specification Drainage Operation.
    - g. Wade.
  - 2. Standard: ASSE 1010 or PDI-WH 201.
  - 3. Type: Copper tube with piston.
  - 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Locate backflow preventers in same room as connected equipment or system.
  - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

- 3. Do not install bypass piping around backflow preventers.
- C. Install water hammer arresters in water piping according to PDI-WH 201.
- D. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- E. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Intermediate atmospheric-vent backflow preventers.
  - 2. Reduced-pressure-principle backflow preventers.
  - 3. Primary, thermostatic, water mixing valves.
- F. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

# 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
  - 1. Test each reduced-pressure-principle backflow preventer and/or double-check backflowprevention assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION 221119

# SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

### 1.1 SUMMARY

- A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:
  - 1. Pipe, tube, and fittings.
  - 2. Special pipe fittings.
- B. See Division 22 Section "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.
- C. In Boys A-110, existing lavatories shall be demolished & new lavatories installed in new locations. New water closets & urinals shall be installed in same locations. Floor drain shall remain in place with new strainer. General Contractor shall demolish existing walls & construct new walls to facilitate plumbing installation, while Plumbing Contractor shall coordinate to minimize wall demolition. Substantial floor saw-cutting is anticipated in this room, for sanitary waste piping.
- D. In Girls A-103, new lavatories, water closets, & urinals shall be installed in same locations. Plumbing Contractor shall provide for new floor drain. Minimal floor saw-cutting is anticipated in this room, for sanitary waste piping.
- E. In Boys B-122, existing lavatories, water closet, urinal, & floor drain shall be demolished & new lavatories, water closets, urinal, & floor drain installed in new locations. General Contractor shall demolish existing walls & construct new walls to facilitate plumbing installation, while Plumbing Contractor shall coordinate to minimize wall demolition. Substantial floor saw-cutting is anticipated in this room, for sanitary waste piping.
- F. In Girls B-121, existing lavatories, water closet, & floor drain shall be demolished & new lavatories, water closets, & floor drain installed in new locations. General Contractor shall demolish existing walls & construct new walls to facilitate plumbing installation, while Plumbing Contractor shall coordinate to minimize wall demolition. Substantial floor saw-cutting is anticipated in this room, for sanitary waste piping.
- G. In Toilet C-137, new lavatory and water closet shall be installed in same locations. Existing urinal shall be demolished. Existing floor drain shall be demolished & new floor drain shall be installed. Minimal floor saw-cutting is anticipated in this room, for sanitary waste piping.
- H. In Toilet C-138, new lavatory and water closet shall be installed in same locations. Existing floor drain shall be demolished & new floor drain shall be installed. Minimal floor saw-cutting is anticipated in this room, for sanitary waste piping.
- I. Due to unknown underslab sanitary waste piping locations & sizes, Plumbing Contractor is encouraged to provide camera inspection prior to any floor saw-cutting.

### 1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

### 1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.
- C. Water service line must be installed at least 10 feet horizontally from any manhole, catchbasin, or any other potential source of contamination (see Minnesota Rules, part 4715.1710, subpart 3).

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

A. 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.

### 2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Hub-and-Spigot, Cast-Iron Pipe and Fittings: ANSI 21.8, ASTM A 74, Service class.
  - 1. Gaskets: ANSI 21.51, AWWA C151, ASTM C564, rubber.

## 2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.
  - 1. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
  - 2. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
    - a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
    - b. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

3. Hubless cast iron pipe and fittings shall be compliant with CISPI standard 301-69T and CSA/CAN 3-B70.

## 2.4 PVC PIPE AND FITTINGS

- PVC unthreaded Pipe: ASTM D 2665, NSF14, CSA-B181.2, CS272, ASTM D 2665, Schedule 40, solid-wall drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
  - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Solvent Cement: ASTM D 2564.
  - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

## 2.5 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
  - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections 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, Non-pressure 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; a division of MCP Industries, Inc.
      - 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
    - b. Standard: ASTM C 1173.
    - c. Description: Elastomeric, sleeve-type, 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 C 564, rubber.
  - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- 4. Shielded, Non-pressure Transition Couplings:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cascade Waterworks Mfg. Co.
    - 2) Mission Rubber Company; a division of MCP Industries, Inc.
  - b. Standard: ASTM C 1460.
  - 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.

# PART 3 - EXECUTION

# 3.1 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
  - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 2-1/2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
  - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 2-1/2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.2 percent downward in direction of flow.
  - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- I. Install ABS soil and waste drainage and vent piping according to ASTM D 2661.
- J. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- K. Install underground ABS and PVC soil and waste drainage piping according to ASTM D 2321.
- L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

# 3.2 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
  - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- C. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
  - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

### 3.3 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
  - 1. Install transition couplings at joints of piping with small differences in OD's.
  - 2. In Drainage Piping: Shielded, non-pressure transition couplings.

### 3.4 VALVE INSTALLATION

- A. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
  - 1. Use gate or full-port ball valve for piping NPS 2 and smaller.
  - 2. Use gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, downstream from shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
  - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
  - 2. Install backwater valves in accessible locations.
  - 3. Backwater valves are specified in Division 22 Section "Sanitary Waste Piping Specialties."

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
  - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

- 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
- 2. NPS 3: 60 inches with 1/2-inch rod.
- 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
- 4. NPS 6and larger: 60 inches with 3/4-inch rod.
- 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
  - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  - 3. NPS 2: 10 feet with 3/8-inch rod.
  - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  - 5. NPS 3: 12 feet with 1/2-inch rod.
  - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
  - 7. NPS 6 and larger: 12 feet with 3/4-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
  - 2. NPS 3: 48 inches with 1/2-inch rod.
  - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
  - 4. NPS 6 and larger: 48 inches with 3/4-inch rod.
- J. Install supports for vertical ABS and PVC piping every 48 inches.
- K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

## 3.6 CONNECTIONS

- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect drainage and vent piping to the following:
  - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Sanitary Waste Piping Specialties."
  - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Sanitary Waste Piping Specialties."

4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

# 3.7 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 closingin after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.
  - 1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  - 2. Prepare reports for tests and required corrective action.

## 3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### 3.9 **PROTECTION**

A. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

## 3.10 PIPING SCHEDULE

- A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- C. Aboveground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

### SANITARY WASTE AND VENT PIPING

- 1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
- 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
- 3. PVC pipe, PVC socket fittings, and solvent-cemented joints.
- 4. PVC may not be used if horizontal lengths are greater than 35 feet in total length. No stack can exceed 35 feet in total height unless a code approved expansion and contraction joint is installed at intervals not to exceed 35feet. ABS or PVC may not be used if located above a ceiling that is considered a mechanical plenum.
- D. Aboveground, soil, waste, and vent piping NPS 5 and larger shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
  - 3. PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 4. PVC may not be used if horizontal lengths are greater than 35 feet in total length. No stack can exceed 35 feet in total height unless a code approved expansion and contraction joint is installed at intervals not to exceed 35feet. ABS or PVC may not be used if located above a ceiling that is considered a mechanical plenum.
- E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
  - 1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
  - 4. PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 5. PVC piping system must be laid on a continuous granular bed. Installation must comply with ASTM D2321.
- F. Underground, soil and waste Piping NPS 5 and larger shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and compression joints.
  - 2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
  - 3. PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 4. ABS or PVC piping system must be laid on a continuous granular bed. Installation must comply with ASTM D2321.

END OF SECTION 221316

# SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
  - 1. Cleanouts.
  - 2. Floor drains/sinks.
  - 3. Miscellaneous sanitary drainage piping specialties.

### 1.2 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  - 1. Product data

## PART 2 - PRODUCTS

### 2.1 CLEANOUTS

- A. Exposed Cleanouts (CO):
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Sioux Chief #851 provide with coring plug and coring sleeve to protect drain during concrete pour, or a comparable product by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Josam Company; Josam Div.
    - b. MIFAB.
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Sioux Chief Manufacturing Company, Inc.,
    - e. Watts Drainage Products Inc.
    - f. Zurn Plumbing Products Group; Specification Drainage Operation.
    - g. Wade.

- 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
- 3. Size: Same as connected drainage piping.
- 4. Body Material: Hubless, cast-iron soil pipe connected piping.
- 5. Closure: Adjustable countersunk or raised-head, brass.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Floor Cleanouts (FCO):
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Sioux Chief #852 provide with coring plug and coring sleeve to protect drain during concrete pour, or a comparable product by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Josam Company; Josam Div.
    - b. MIFAB.
    - c. Sioux Chief Manufacturing Company, Inc.
    - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - e. Watts Drainage Products Inc.
    - f. Zurn Plumbing Products Group; Light Commercial Operation.
    - g. Zurn Plumbing Products Group; Specification Drainage Operation.
    - h. Wade.
  - 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
  - 3. Size: Same as connected branch.
  - 4. Type: Adjustable housing, as required to match finished floor level.
  - 5. Body or Ferrule: to match piping.
  - 6. Clamping Device: Not required.
  - 7. Outlet Connection: Spigot or Threaded.
  - 8. Closure: Brass plug with straight threads and gasket, Cast-iron plug or Plastic plug to match body.
  - 9. Adjustable Housing Material: Cast iron or Plastic to match pipe with threads.
  - 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy for concrete floor & tile floor. Nickel-bronze, copper alloy with carpet tag (-14) for carpet floors.
  - 11. Frame and Cover Shape: Round.
  - 12. Top Loading Classification: Medium Duty.
  - 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser cleanout.
- C. Wall Cleanouts (WCO):
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Josam #58790 or a comparable product by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Josam Company; Josam Div.
    - b. MIFAB
    - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    - d. Tyler Pipe; Wade Div.
    - e. Sioux Chief Manufacturing Company, Inc.

- f. Watts Drainage Products Inc.
- g. Zurn Plumbing Products Group; Specification Drainage Operation.
- h. Wade.
- 2. Standard: ASME A112.36.2M. Include wall access.
- 3. Size: Same as connected drainage piping.
- 4. Body: as required to match connected piping.
- 5. Closure: Countersunk or raised-head, plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

## 2.2 FLOOR DRAINS

A. Floor Drains: As scheduled on drawings.

# 2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
  - 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
  - 2. Size: Same as connected waste piping with increaser fitting of size indicated.
- B. Deep-Seal Traps:
  - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
  - 2. Size: Same as connected waste piping.
    - a. NPS 2: 4-inch- minimum water seal.
    - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- C. Stack Flashing Fittings:
  - 1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
  - 2. Size: Same as connected stack vent or vent stack.
- 2.4 Vent Caps:
  - A. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
  - B. Size: Same as connected stack vent or vent stack.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Position floor drains for easy access and maintenance.
  - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
  - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- G. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

- 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
- 2. Size: Same as floor drain inlet.
- I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- J. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

# 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

# 3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.

## 3.4 **PROTECTION**

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

END OF SECTION 221319

# SECTION 224000 - PLUMBING FIXTURES

# PART 1 - GENERAL

## 1.1 SECTION REQUIREMENTS

- A. Submittals:
  - 1. Product Data for each type of plumbing fixture, including trim, fittings, accessories, appliances, appurtenances, equipment, and supports.
  - 2. Documentation indicating flow and water consumption requirements.

### PART 2 - PRODUCTS

## 2.1 PER FIXTURE SCHEDULE LISTED ON DRAWINGS

- A. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" and "Americans with Disabilities Act" for plumbing fixtures for people with disabilities.
- B. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components Health Effects," for fixture materials that will be in contact with potable water.

## PART 3 - EXECUTION

### 3.1 INSTALLATIONS

- A. Install fitting insulation kits on fixtures for people with disabilities.
- B. Install fixtures with flanges and gasket seals.
- C. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- D. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- E. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated. Provide floor mounted carriers for all wall mount lavatories, urinal, and water closets.

- F. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- G. Fasten wall-mounted fittings to reinforcement built into walls.
- H. Fasten counter-mounting plumbing fixtures to casework.
- I. Secure supplies to supports or substrate within pipe space behind fixture.
- J. Set shower receptors and mop basins in leveling bed of cement grout.
- K. Install individual supply inlets, supply stops, supply risers, and tubular brass traps with cleanouts at fixture.
- L. Install water-supply stop valves in accessible locations.
- M. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes unless otherwise indicated.
- N. Install disposers in sink outlets. Install switch where indicated, or in wall adjacent to sink if location is not indicated.
- O. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.
- P. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.
- Q. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.
- R. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.
- S. Install piping connections between plumbing fixtures and piping systems and plumbing equipment. Install insulation on supplies and drains of fixtures for people with disabilities.
- T. Ground equipment.

END OF SECTION 224000

# SECTION 230010 – GENERAL REQUIREMENTS

PART 1 - GENERAL

## 1.1 CONDITIONS

A. The General Conditions, Supplementary General Conditions and Division 1 General Requirements apply to Division 23.

### 1.2 SUMMARY OF WORK

- A. The work to be done under this Specification and the accompanying drawings includes the furnishing of labor, materials, equipment and services necessary for the proper completion of plumbing work
- B. The omission of express reference to any parts necessary for or reasonably incidental to a complete installation shall not be construed as releasing the contractor from furnishing such parts.
- C. All work shall be performed in a clean and workmanlike manner. Care shall be exercised to minimize any inconvenience or disturbance to other areas of the building which are to remain in operation. Isolate work areas by means of temporary partitions and/or tarps to keep dust and dirt with construction area.
- D. No equipment, etc. shall be removed, disconnected, or shut down without prior review with the Owner and/or Engineer to confirm that areas to remain in operation will not be affected. If any areas not within the scope of work are affected by any shutdown, removal, or disconnection, sufficient advance notice must be given to the Owner indicating which areas will be affected, when the proposed shutdown will occur, and for how long a period of time.
- E. All items indicated to be demolished or removed shall become property of the contractor and shall be disposed of off-site unless indicated otherwise.
- F. Contractor shall field verify all dimensions and existing conditions prior to proceeding with any work. Where discrepancies occur between these documents and existing conditions, the discrepancy shall be reported to the Owner and/or Engineer for expediting and resolution.
- G. Clean the job site daily and remove from the premises any dirt and debris caused by the performance of the work included in this contract.
- H. Use of the Owner's elevators and building corridors for handling of the removed equipment and materials shall be at the direction of the Owner and shall be coordinated with his operations.
- I. The Contractor shall be responsible for the safekeeping of his own property on the job site. Owner assumes no responsibility for protection of properties against fire, theft, and environmental conditions.
- J. Where used, the term "Provide" shall mean "Furnish and Install."

- K. The Contractor shall coordinate his work with all other trades.
- L. Contractor to provide for final connections to equipment, including Owner-provided equipment.

# 1.3 INSPECTION OF SITE

- A. Before submitting a proposal on the work contemplated in this Specification and accompanying drawings, each bidder shall examine the site and check as to the means of making connections to services and shall familiarize himself with the existing conditions and limitations. No extras will be allowed because of the contractor's misunderstanding as to the amount of work involved or lack of knowledge of any site conditions which may affect the work. Any apparent variance of the plan or specification from the existing conditions at the site shall be called to the attention of the Engineer during the bid period so clarification can be made by addendum.
- B. The existence of any wires, conduits, pipes, ducts, or other facilities are shown in a general way only. It will be the duty of the bidding contractors to visit the site and make exact determination of the existence of such facilities prior to the submission of bids. It is understood that the bidders will be responsible for making the exact determination of the location and condition of such facilities.

## 1.4 FEES, PERMITS, TAXES, AND INSPECTIONS

- A. Regular inspections shall be requested by the contractor as required by regulations. Charges for the inspections by regulating agencies of installations or plans and specifications shall be paid by the contractor.
- B. All permits, inspections and licenses shall be secured and paid for before actual work is started.
- C. The contractor, after completion of work, shall furnish to the Owner a Certificate of Final Inspection and approval from the inspection bureau having jurisdiction.
- D. State and Local Sales Tax. The Mechanical Contractor shall include all state and local sales tax in the bid. The contractor shall maintain accurate records of all taxes and furnish such records to the Owner upon request.

## 1.5 CODES AND STANDARDS

- A. Contractor shall comply with all current ordinances, laws, regulations and codes applicable to the work involved. This does not relieve the contractor from furnishing and installing work shown or specified which may be beyond the requirement of such ordinances, laws, regulations and codes.
- B. In case of difference between building codes, specifications, state laws, local ordinances, industry standards, and utility company regulations and the Contract Documents, the most stringent shall govern. The contractor shall promptly notify the Engineer in writing of such difference.

- C. Non-Compliance: Should the contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards and utility company regulations, he shall bear all costs arising in correcting the deficiencies.
- D. Contractor shall initiate, maintain, and supervise all safety pre-cautions required for his work including regulations of the Occupational Safety and Health Administration (OSHA).
- E. UL Compliance. All equipment and systems specified in Division 23 shall comply with all applicable UL safety standards and have all required UL listings. All systems shall have UL-listed components, as well as a UL listing for the entire system. When a UL listing for the system is not available, the system shall be tested by an independent laboratory or certified by an impartial licensed professional engineer per Indiana Statutes.

## 1.6 DRAWINGS

- A. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed.
- B. The drawings are to scale as noted but the contractor shall refer to Architectural and structural Drawings for exact location of partitions, walls, beams, shafts, equipment, etc.
- C. Each trade shall avail himself of drawings and specifications of all other trades and make an effort to coordinate his work with all other trades.
- D. The contractor, before roughing-in facilities or installation of any equipment, shall consult all drawings, architectural, structural, mechanical, etc. for finishes, locations of ceiling, ceiling types, structural members, pipes, ducts, recessed lighting fixtures, conduits, etc., which may affect the installation. The contractor in installing his equipment shall leave adequate room for the installation of equipment by other contractors or subcontractors where space is limited.
  - 1. Consideration has been given to such condition of limited space in the preparation of the drawings and the locations and dimensions of equipment have been selected accordingly. The contractor shall be warned that in certain instances, space may be limited to the extent that there may be only one arrangement of equipment or facilities which will allow installation of same.
  - 2. Where connections are made to equipment furnished by others, the contractor shall obtain exact location of connection from persons furnishing that equipment. The contractor shall confirm all voltage, circuit breaker, and wiring requirements prior to installation.
- E. Discrepancies discovered before or after work has started, shall be brought to the attention of the Engineer immediately and the Engineer reserves the right to require minor changes in the work to eliminate such discrepancies with no change in contract cost.
- F. The plans and specifications are complementary and what is called for in either one shall be as binding as if called for in both.
- G. Where a disagreement exists in the plans and specifications, the item or arrangement of better quality, greater quantity or higher cost, shall be included.

### 1.7 CAD DRAWING FILES

- A. All Division 23 electronic CAD drawing files provided by the Architect/Engineer for this project are for use solely with respect to this project. The Mechanical Contractor may request copies of the Division 23 CAD drawing files for the preparation of shop drawings. However, CAD drawing files shall not be used on other projects, for additions to this project, or for completion of this project by others. Any intentional or unintentional revisions, additions, or deletions to these Division 23 CAD drawing files shall be made at eh full risk of the person(s) making such revisions, additions, or deletions, and such person(s) shall hold harmless and indemnify Architect/Engineer of any and all responsibilities and liabilities.
- B. The CAD files are not to be construed as updated as-built construction documents. The drawing files reflect only bidding documentation of original Construction Drawings. Addenda or written changes occurring during the construction process will not be incorporated into the Division 23 CAD drawing files.
- C. CAD files will be furnished to the Mechanical Contractor at the sole discretion of the Engineer.

### 1.8 SYMBOLS AND ABBREVIATIONS

A. Refer to Symbols and Abbreviations listed on drawings. Other symbols are in common usage but if uncertainty exists regarding plan symbols or abbreviations they shall be brought to the attention of the Engineer for clarification.

### 1.9 PRIOR APPROVALS

A. Refer to Section 01 60 00 - Product Requirements for submittal procedures of equivalent products.

### 1.10 COORDINATION

- A. Coordinate work with other trades in the installation of equipment, piping, conduit, and ductwork.
- B. Refer to Section 01 31 00 Project Management and Coordination for requirements.
- C. Contractors shall solve all coordination conflicts among themselves when possible. The Engineer will arbitrate when necessary, and his judgment will stand, with no additional cost to the owner.
- D. For equipment requiring connections by other contractors, provide Architect approved submittals to the appropriate contractors. Approved submittals are to depict the required connections.
- E. All shop drawings shall be sent to all appropriate contractors for coordination prior to fabrication.

### 1.11 TEMPORARY SERVICES

A. The Mechanical Contractor shall carefully examine all parts of the General Requirements for requirements regarding temporary heat, temporary light, and other services. Contractor shall include in his bid an amount to cover his portion of such services.

## PART 2 - PRODUCTS

## 2.1 FIRE BARRIER SEALING SYSTEM

A. This contractor shall furnish all labor and materials needed to preserve the fire, smoke, and water containment integrity of the fire rated floors, walls and ceilings penetrated by ductwork, piping, or conduit. Refer to Section 07 84 13 - Penetration Firestopping.

### 2.2 SPARE PARTS

A. Provide products, spare parts, and maintenance materials as specified in other sections of the Project Manual. Refer to Division 1.

## PART 3 - EXECUTION

### 3.1 CUTTING AND PATCHING

- A. This contractor shall perform all cutting and patching necessary in order to perform this work unless noted on drawings to be performed by the General Contractor - however, special permission shall be obtained from the engineer before cutting structural members or finished material. Patching shall be performed in such a manner as to leave no visible trace and to return the part affected to the condition of undisturbed work. Patching work shall be performed by workers experienced, skilled, and licensed for the particular type of work involved. Inferior work will not be accepted. Holes in masonry shall be drilled in rotary drills. Impact tools shall not be used.
- B. Prevent the spread of dust, debris and other material into adjacent areas.

### 3.2 DEMOLITION

A. Disconnect and remove items noted and as directed. Each Contractor is responsible to remove all equipment, materials, and accessories associated with removed items (insulation, hanger, etc.) under his Contract under the provisions of Division 0.

# 3.3 HOLES THROUGH MASONRY

- A. The Mechanical Contractor shall provide all holes and openings required for mechanical work.
- B. Holes made in existing masonry for mechanical equipment shall be core drilled.

- C. The contractor shall be responsible for grouting air-tight any openings adjacent to raceways etc. to seal against passage of air, smoke or vapors. Maintain ratings of fire rated partitions.
- D. The contractor shall be responsible for providing and disposing of water used in the core drilling operation. Work shall be scheduled and other trades coordinated so that damage will not result from the use of water.
- E. The contractor shall install in each wall and floor sleeve opening fire rated material to maintain the fire rating of partition or floor.
- F. Contractor shall maintain watertight construction.

# 3.4 FOUNDATIONS AND ANCHOR BOLTS

- A. Install all mechanical and motor-driven equipment and associated accessories on 4" high reinforced concrete foundations, unless otherwise specified or noted on Drawings. Extend foundation to support vibration isolation equipment where required.
- B. Foundation to be provided and installed by the General Contractor under provisions of Section 03 30 00.
- C. Provide General Contractor with exact location and dimensions of foundations.
- D. Where the equipment to be installed requires anchor bolts, bolts shall be set to template as the foundations are formed.
- E. 45-degree chamfer corners and edges of foundations by moldings placed in the forms.
- F. Smooth exposed portions of foundations which are rough after removing forms with a mixture of one part cement to two parts sand.

### 3.5 WALL CHASES AND RECESSES

- A. Supervise the construction of chases and recesses in walls for plumbing systems.
- B. Provide the necessary information for the proper size and location to the Masonry Contractor in a timely manner.

### 3.6 CONCRETE BASES AND PADS

A. Concrete bases and pads for mechanical equipment shall be provided by the mechanical contractor. Provide concrete pads for all floor mounted and exterior grade mounted mechanical equipment.

### 3.7 ELECTRICAL CONNECTIONS TO EQUIPMENT

A. Electrical circuits, conduit, raceways, wiring and connections to devices and equipment furnished under Division 23 that are not depicted on the Electrical Drawings or indicated in

Division 26 and 28 specifications are the responsibility of the Contractor providing the equipment.

B. Mechanical contractor to coordinate mechanical equipment breaker sizes with electrical contractor prior to ordering.

# 3.8 CHANGING OUTLETS

A. When necessary to fit and center with tile, plaster, paneling and other coverings of the wall, floor or ceiling space, shift the equipment, pipe, or other outlet, as directed by the Architect/Engineer.

## 3.9 RECORD DRAWING NOTES

- A. Contractor shall clearly mark up a set of prints in red to show installed equipment, material and conditions that vary from the original. A complete set of drawings shall be kept at job site at all times upon which each field change shall be marked including all depths, dimensioned locations, sizes, etc. See Division 1.
- B. As work progresses, the contractor shall record all changes and deviations from the Contract Drawings. Refer to Division 1 for specific requirements. Include the following as a minimum:
  - 1. Record exact location and elevation of underground conduits, duct banks and direct burial wiring.
  - 2. Prepare Record Drawing changes for all plumbing work within the building that occurs during the progress of construction. Include such changes as:
    - a. Addenda
    - b. Change orders
    - c. Relocation of devices during construction
    - d. Routing of piping.
    - e. Final locations of equipment.
    - f. Value engineering.
- C. The Record Drawings shall be maintained at the job site and be subject to review by the owner or architect/engineer during the construction period. This record keeping requirement shall not be construed as authorization for the contractor to make changes in the layout without definite instructions by the architect/engineer in each case.
- D. Upon completion of the job, submit scan copy of Project Record Drawings.

## 3.10 OPERATING AND MAINTENANCE MANUAL(S)

- A. Refer to Section 01 78 23 Operation and Maintenance Data for general requirements.
- B. Cross out or delete all information shown on Shop Drawings and other literature definitely not applying to this particular project and its equipment installed.

C. Manuals that do not meet the foregoing criteria will be rejected and returned to the contractor for resubmittal.

## 3.11 FINAL OBSERVATION

A. A final observation of the mechanical systems by the Architect/Engineer will be conducted before the contract can be considered complete. The contractor shall inform the Engineer in writing when the mechanical installation is complete and ready for final observation. The Engineer shall visit the project and provide a list of items that need to be corrected or completed to achieve final completion. Should the Engineer attend the project to conduct the final observation and discovers that the work is not sufficiently complete to perform this task, then the contractor shall compensate the Engineer for his time. The contractor shall remain responsible for completing his work and requesting the Engineer to return for a final observation.

### 3.12 TESTS

- A. The contractor shall test the equipment installed under this specification and shall demonstrate its proper operation to the engineer when requested by the engineer.
- B. No equipment shall be tested, or operated for any purpose until it has been fully prepared, connected and made ready for normal operation. Damage to equipment occasioned by improper or ill-timed operation or testing shall be made good, at the contractor's expense, before final inspection and acceptance.

## 3.13 TRAINING

A. Refer to Section 01 79 00 - Demonstration and Training for general requirements.

## 3.14 MATERIAL AND WORKMANSHIP

- A. All material and workmanship must be of the best throughout. Material and equipment must be new and must be adequately protected from damage and dirt. Each item or system shall be listed, inspected, and approved by a nationally recognized testing laboratory and shall bear a label indicating such. The Engineer reserves the right to reject material or workmanship not in accordance with the Specifications, either before or after installation. Contractor will be held responsible for defects in the material and workmanship which may appear during guarantee period after the building has been accepted. Such defects must be repaired or defective material replaced by the contractor at no expense to the owner.
- B. No asbestos, hazardous, or PCB containing materials of any type shall be used on this project.
- C. The contractor shall be responsible for the proper installation of all systems in this contract and shall guarantee to remedy free of charge any defects in workmanship and materials for a period of 12 months from substantial completion.

## 3.15 FIRE RATED CEILINGS

- A. All enclosures shall be of sufficient size and depth to permit proper mounting and operation of equipment. Verify requirements with equipment manufacturer.
- B. Refer to Architectural drawings for locations of fire rated ceilings.

# 3.16 FINAL NAMES AND NUMBERS FOR ROOMS AND DOORS

A. Contractor shall note that names and numbers of rooms and doors on the architectural plans may not be the same as that selected by the owner for use in their final naming and/or numbering scheme. Contractor shall use final room names and numbering system as directed by the owner. This shall apply to all labeling, identification, and programming that is required by the Division 23 drawings and specifications.

END OF SECTION 230010

# SECTION 230500 - COMMON WORK RESULTS FOR HVAC

## PART 1 - GENERAL

## 1.1 SECTION REQUIREMENTS

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

### PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Hangers and Supports for Plumbing Piping Equipment:
  - 1. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
    - a. Design supports for multiple pipes capable of supporting combined weight of supported systems, and system contents.
    - b. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
    - c. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

## 2.2 SLEEVES AND SLEEVE SEALS

- A. Galvanized-Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- B. PVC Pipe: ASTM D 1785, Schedule 40.
- C. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- D. Modular rubber sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Stainless steel.
  - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

- E. Stack-Seal Fitting: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

# 2.4 ESCUTCHEONS AND FLOOR PLATES

- A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- C. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

## 2.5 PRESSURE GAGES AND TEST PLUGS

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
  - 1. Standard: ASME B40.100.
  - 2. Case: Sealed Open-front, pressure relief; cast aluminum; 4-1/2-inch nominal diameter.
  - 3. Movement: Mechanical, with link to pressure element and connection to pointer.
  - 4. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
  - 5. Pointer: Dark-colored metal.
  - 6. Window: Plastic.
  - 7. Ring: Metal.
  - 8. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- B. Test Plug: Corrosion-resistant brass or stainless-steel body with two self-sealing rubber core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping. Minimum pressure and temperature rating of 500 psig at 200 deg F.

# 2.6 HANGERS AND SUPPORTS FOR HVAC

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
  - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe 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.
- C. Fastener Systems:
  - 1. Verify suitability of fasteners in this article for use in lightweight concrete or concrete slabs less than 4 inches thick.
  - 2. 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.
  - 3. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- D. Miscellaneous Materials:
  - 1. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
  - 2. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
    - a. Properties: Nonstaining, noncorrosive, and nongaseous.
    - b. Design Mix: 4000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

## 3.1 GENERAL PIPING INSTALLATIONS

- A. Install piping free of sags and bends.
- B. Install fittings for changes in direction and branch connections.
- C. Sleeves:
  - 1. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
  - 2. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
    - a. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
  - 3. Install stack-sleeve fittings in new slabs as slabs are constructed.
  - 4. Exterior Wall, Pipe Penetrations: Mechanical sleeve seals installed in steel or cast-iron pipes for wall sleeves.
  - 5. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078446 "Penetration Firestopping."

- D. Sleeve-Seal-System Installation:
  - 1. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
  - 2. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
- E. Escutcheons & Floor Plates:
  - 1. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
  - 2. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 3. Install floor plates for piping penetrations of equipment-room floors.
  - 4. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- F. Install unions at final connection to each piece of equipment.
- G. Install dielectric unions and flanges to connect piping materials of dissimilar metals in gas piping.
- H. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals in water piping.

## 3.2 HANGERS AND SUPPORTS

- A. Comply with MSS SP-69 and MSS SP-89. Install building attachments within concrete or to structural steel.
- B. Install hangers and supports to allow controlled thermal and seismic movement of piping systems.
- C. Install powder-actuated fasteners and mechanical-expansion anchors in concrete after concrete is cured. Do not use in lightweight concrete or in slabs less than 4 inches thick.
- D. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  - 1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  - 2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow offcenter closure for hanger installation before pipe erection.
  - 3. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
- 4. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
- 5. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
- F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

# 3.3 GENERAL EQUIPMENT INSTALLATIONS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Mix and install grout for pump and other equipment base plates, and anchors. Place grout, completely filling equipment bases.

# SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

## 1.1 SECTION REQUIREMENTS

- A. Coordination:
  - 1. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
    - a. Motor controllers.
    - b. Torque, speed, and horsepower requirements of the load.
    - c. Ratings and characteristics of supply circuit and required control sequence.
    - d. Ambient and environmental conditions of installation location.

### PART 2 - PRODUCTS

#### 2.1 MOTOR CHARACTERISTICS

- A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
  - 1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- C. Polyhase Motors:
  - 1. Description: NEMA MG 1, Design B, medium induction motor.
    - a. Service Factor: 1.15.
  - 2. 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.
  - 3. Rotor: Random-wound, squirrel cage.
  - 4. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
  - 5. Temperature Rise: Match insulation rating.
  - 6. Insulation: Class F.
  - 7. Code Letter Designation:
    - a. Motors 15 HP and Larger: NEMA starting Code F or Code G.

- b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- 8. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- D. Polyphase Motors with Additional Requirements
  - 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.
- E. Single Phase Motors:
  - 1. Motors larger than 1/20 hp shall 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 shall automatically reset when motor temperature returns to normal range.
- F. VFD Driven Motors
  - 1. Equip with AEGIS Bearing Protection Ring

# PART 3 - EXECUTION (Not Used)

# SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

# 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. Escutcheons.
  - 2. Floor plates.

# 1.3 ACTION SUBMITTALS

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

## PART 2 - PRODUCTS

# 2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

# 2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, castbrass or split-casting brass type with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plate or rough-brass finish.
    - g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated or rough-brass finish.
  - 2. Escutcheons for Existing Piping:
    - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
    - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
    - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
    - f. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated or rough-brass finish.
    - g. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
    - h. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chromeplated or rough-brass finish.
    - i. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

- 1. New Piping: One-piece, floor-plate type.
- 2. Existing Piping: Split-casting, floor-plate type.

# 3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

# SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

# 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. Thermometers.
  - 2. Gages.
  - 3. Test plugs.
  - 4. Flowmeters.
  - 5. Thermal-energy meters.
- B. Related Sections:
  - 1. Division 23 Section "Facility Natural-Gas Piping" for gas meters.

# 1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermometers gages and flowmeters indicating manufacturer's number, scale range, and location for each.
- C. Product Certificates: For each type of thermometer gage and flowmeter, signed by product manufacturer.
- D. Operation and Maintenance Data: For flowmeters to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

# 2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Palmer Wahl Instruments Inc.
  - 2. Trerice, H. O. Co.
  - 3. Weiss Instruments, Inc.
  - 4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Die-cast aluminum 9 inches.
- C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.
- D. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.
- E. Window: Glass Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- F. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.
- G. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

#### 2.2 DUCT-TYPE, LIQUID-IN-GLASS THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Palmer Wahl Instruments Inc.
  - 2. Trerice, H. O. Co.
  - 3. Weiss Instruments, Inc.
- B. Case: Die-cast aluminum, 7 inches long.
- C. Tube: Red or blue reading, organic filled, with magnifying lens.
- D. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.
- E. Window: Glass.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Metal, for installation in mounting bracket and of length to suit installation.

#### METERS AND GAGES FOR HVAC PIPING

- H. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.
- I. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

#### 2.3 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 2. KOBOLD Instruments, Inc.
  - 3. Marsh Bellofram.
  - 4. Trerice, H. O. Co.
  - 5. Weiss Instruments, Inc.
  - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.
- C. Element: Bourdon tube or other type of pressure element.
- D. Movement: Mechanical, connecting element and pointer.
- E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
- F. Pointer: Red metal.
- G. Window: Glass.
- H. Ring: Metal.
- I. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- J. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.
- K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

# 2.4 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AMETEK, Inc.; U.S. Gauge Div.
  - 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 3. Marsh Bellofram.
  - 4. Palmer Wahl Instruments Inc.
  - 5. Trerice, H. O. Co.

- 6. Weiss Instruments, Inc.
- 7. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.
- C. Element: Bourdon tube or other type of pressure element.
- D. Movement: Mechanical, connecting element and pointer.
- E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
- F. Pointer: Red metal.
- G. Window: Glass.
- H. Ring: Metal.
- I. Connector: Back union type.
- J. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.
- K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

# 2.5 BIMETALLIC-ACTUATED DIAL THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 2. Ernst Gage Co.
  - 3. Eugene Ernst Products Co.
  - 4. Marsh Bellofram.
  - 5. Palmer Wahl Instruments Inc.
  - 6. Trerice, H. O. Co.
  - 7. Weiss Instruments, Inc.
  - 8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.
- C. Case: Dry type, stainless steel with 5-inch diameter.
- D. Element: Bimetal coil.
- E. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
- F. Pointer: Red.

- G. Window: Glass.
- H. Ring: Stainless steel.
- I. Connector: Adjustable angle type.
- J. Stem: Metal, for thermowell installation and of length to suit installation.
- K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

# 2.6 THERMOWELLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AMETEK, Inc.; U.S. Gauge Div.
  - 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 3. Ernst Gage Co.
  - 4. Marsh Bellofram.
  - 5. Palmer Wahl Instruments Inc.
  - 6. Trerice, H. O. Co.
  - 7. Weiss Instruments, Inc.
  - 8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

# 2.7 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AMETEK, Inc.; U.S. Gauge Div.
  - 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
  - 3. Ernst Gage Co.
  - 4. Eugene Ernst Products Co.
  - 5. KOBOLD Instruments, Inc.
  - 6. Marsh Bellofram.
  - 7. Palmer Wahl Instruments Inc.
  - 8. Trerice, H. O. Co.
  - 9. Weiss Instruments, Inc.
  - 10. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
  - 1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.
  - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.

- 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
- 4. Movement: Mechanical, with link to pressure element and connection to pointer.
- 5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
- 6. Pointer: Red.
- 7. Window: Glass.
- 8. Ring: Metal.
- 9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
- 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
- 11. Range for Fluids under Pressure: Two times operating pressure.
- C. Remote-Mounting, Dial-Type Pressure Gages: ASME B40.100, indicating-dial type.
  - 1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.
  - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
  - 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
  - 4. Movement: Mechanical, with link to pressure element and connection to pointer.
  - 5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
  - 6. Pointer: Red.
  - 7. Window: Glass.
  - 8. Ring: Metal.
  - 9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
  - 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
  - 11. Range for Fluids under Pressure: Two times operating pressure.
- D. Pressure-Gage Fittings:
  - 1. Valves: NPS 1/4 brass or stainless-steel needle type.
  - 2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
  - 3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

# 2.8 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Flow Design, Inc.
  - 2. Sisco Manufacturing Co.
  - 3. Trerice, H. O. Co.
  - 4. Watts Industries, Inc.; Water Products Div.
- B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- D. Core Inserts: One or two self-sealing rubber valves.

- 1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
- 2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.
- E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
  - 1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
  - 2. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
  - 3. Carrying case shall have formed instrument padding.

# PART 3 - EXECUTION

# 3.1 THERMOMETER APPLICATIONS

- A. Install liquid-in-glass thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic boiler and chiller.
  - 3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
  - 4. Inlet and outlet of each hydronic heat exchanger.
  - 5. Outside-air, return-air, and mixed-air ducts.
- B. Install direct-mounting, vapor-actuated dial thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic boiler and chiller.
  - 3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
  - 4. Inlet and outlet of each hydronic heat exchanger.
- C. Install remote-mounting, vapor-actuated dial thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic boiler and chiller.
  - 3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
  - 4. Inlet and outlet of each hydronic heat exchanger.
- D. Install bimetallic-actuated dial thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic boiler and chiller.
  - 3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
  - 4. Inlet and outlet of each hydronic heat exchanger.
- E. Install dry-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.
- F. Provide the following temperature ranges for thermometers:

#### METERS AND GAGES FOR HVAC PIPING

- 1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions
- 2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
- 3. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions 30 to 240 deg F, with 2-degree scale divisions.

# 3.2 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.
- B. Install dry -case-type pressure gages at chilled-water inlets and outlets of chillers.
- C. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

# 3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.
- C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.
- D. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.
- E. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- F. Install remote-mounting pressure gages on panel.
- G. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- H. Install needle-valve and syphon fitting in piping for each pressure gage for steam.
- I. Install test plugs in tees in piping.

# 3.4 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy-meter transmitters to meters.

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# 3.5 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.

# SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 Submittals:

A. Product Data: For each type of valve indicated.

# PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

#### 2.2 GENERAL-DUTY VALVES

- A. Valve Sizes: Same as upstream piping unless otherwise indicated.
- B. Valves in Insulated Piping: With 2-inch stem extensions.
- C. End Connections: Threads shall comply with ANSI B1.20.1. Flanges shall comply with ANSI B16.1 for cast-iron valves and with ANSI B16.24 for bronze valves. Solder-joint connections shall comply with ANSI B16.18.
- D. One-Piece, Copper-Alloy Ball Valves: Brass or bronze body with chrome-plated bronze ball, PTFE or TFE seats, and 600-psig CWP rating.
- E. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
- F. Bronze, Swing Check Valves: Class 125, bronze body with bronze disc and seat.
- G. Bronze Gate Valves: Class 125, bronze body with rising stem and bronze solid wedge and union-ring bonnet.
- H. Bronze-Mounted, Cast-Iron Gate Valves: Class 125, OS&Y cast-iron body and solid-wedge disc.
- I. Bronze Globe Valves: Class 125, bronze body with bronze disc and union-ring bonnet.

#### **GENERAL-DUTY VALVES FOR HVAC PIPING**

# PART 3 - EXECUTION

# 3.1 INSTALLATION

- A. Use ball valves for shutoff duty; globe and ball for throttling duty.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves for each fixture and item of equipment.
- D. Install three-valve bypass around each pressure-reducing valve using throttling-type valves.
- E. Install valves in horizontal piping with stem at or above center of pipe.
- F. Install valves in a position to allow full stem movement.
- G. Install check valves for proper direction of flow in horizontal position with hinge pin level.
- H. Provide for replacement of (6) existing <sup>1</sup>/<sub>2</sub>" & <sup>3</sup>/<sub>4</sub>" Griswold #CPP-2IRIS automatic flow control valves with new valves, at existing VAV box locations. Re-balance water flow at each VAV box location, and at (1) base-mount pump upon completion. Coordinate specific VAV boxes with Engineer.

# SECTION 230525 – ROOF CURBS, EQUIPMENT SUPPORT RAILS, AND PIPE PORTALS

PART 1 - GENERAL

## 1.1 SECTION INCLUDES

A. Qualitative requirements for roof curbs for equipment mounting and piping penetrations.

## 1.2 SUBMITTALS

A. Submittals are required and shall include material, quantities, and dimensions.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Curbs, Support Rails, and Portals: Factory built products; manufactured by a company normally engaged in production of such products.
- B. Full perimeter, seismic design, insulated. Curbs shall be designed by registered professional engineer, with signed/stamped calculations provided.
- C. Base Plates: Designed and fabricated at an angle to match pitch of roof when not on a flat roof. After curb, support, or portal is installed, top surface shall be level and base plate shall bear fully on roof deck.
- D. Coordinate configuration, size, and arrangement of curbs, supports, and portals with respective equipment and roof construction. Provide integral cant where required, coordinated with roof details.
- E. Curb Height: Per drawing.
- F. Manufacturer: Certify respective curbs and support rails will support the installed loads they will be subjected to.

# 2.2 COMPONENTS

- A. Roof Curbs
  - 1. Roof curb shall be constructed of galvanized steel with welded corner beams, reinforced on sides 36 inches and greater; equipped with integral base plate, pressure treated wood nailer strip.
  - 2. Curbs shall be pre-insulated with 1-1/2" rigid insulation.
  - 3. Top of curb shall set dead level.
  - 4. Base of curb shall match roof slope.

#### **ROOF CURBS, EQUIPMENT SUPPORT RAILS, PIPE PORTALS**

- 5. Provide 18 inches for kitchen hood exhaust fans.
- B. Box Curb
  - 1. Box section curbs shall be constructed of welded, heavy gauge galvanized steel with mitered and welded corners, integral base plate, and pressure treated wood nailer.
  - 2. Curb shall be insulated with minimum 1-1/2" rigid insulation.
- C. Equipment Support
  - 1. Rails shall be 18 gauge welded galvanized steel with a welded galvanized counterflashing. Unit to have integral base plate, and 2 by 4 pressure treated wood nailer.
  - 2. Rails to be of the length and strength required to support the specified equipment.
  - 3. Equipment rails shall be internally reinforced to conform with manufacturers load bearing factors.
- D. Pipe Roller Supports
  - 1. Pipe support shall be constructed from heavy gauge galvanized steel with continuous welded corner seams, 2 by 4 treated wood nailer, galvanized steel counterflashing and galvanized steel channel track.
- E. Pipe Portals
  - 1. Manufacturer: Roofing Products and Systems (RPS)
  - 2. Curb shall be covered with a thermoplastic cover, fastening screws, graduated step boots with stainless steel adjustable clamps.
  - 3. Boots: Neoprene, stepped configuration with stepped sizes corresponding to pipe external dimensions.
  - 4. Band Clamps: Stainless steel, secured by a stainless-steel worm screw and rack arrangement.

# PART 3 - EXECUTION

# 3.1 INSTALLATION OF ROOF CURBS AND SUPPORT RAILS

- A. Provide curbs and rails, as applicable, to support respective equipment installed on roof.
- B. Provide support rails, equipped with appropriate brackets and hardware to support pipe, ductwork, etc. installed across roof.
- C. Roof curbs and equipment rails shall be mounted with top dead level, properly anchored to the deck.
- D. Coordinate curb and rail installation with deck and roofing work. Install curbs and rails directly on structural deck, not on insulation or roofing.
- E. Securely attach curbs and rails to deck with bolts or other appropriate fasteners, or by welding.

- F. Where curbs or pedestals are installed on existing roofs, roofing and insulation shall be carefully cut and patched to allow curb or pedestal to set on structural roof.
- G. Roof curbs for metal roof systems shall be provided by the metal roof system manufacturer.

# 3.2 INSTALLATION OF PIPE PORTALS

- A. Provide pipe portals for pipe that passes through roof, located where required and where shown on Drawings.
- B. If portal locations are not shown on drawing, coordinate piping arrangement to route as many pipes as practical through individual portals to keep quantity of portals to a minimum.
- C. Follow manufacturer's recommendations and instructions for arrangement, installation, etc.

# SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes:
  - 1. Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.

#### 1.2 REFERENCES

- A. American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
  - 1. ANSI/ASME B31.1, Power Piping, (SI Edition).
- B. American Society for Testing and Materials (ASTM)
  - 1. ASTM A125, Specification for Steel Springs, Helical, Heat-Treated.
  - 2. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - 3. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
- C. Factory Mutual (FM)
- D. Health Canada / Workplace Hazardous Materials Information System (WHMIS).
  - 1. Materials Safety Data Sheets (MSDS).
- E. Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - 1. MSS SP-58, Pipe Hangers and Supports Materials, Design and Manufacture.
  - 2. ANSI/MSS SP-69, Pipe Hangers and Supports Selection and Application.
  - 3. MSS SP-89, Pipe Hangers and Supports Fabrication and Installation Practices.
- F. Underwriter's Laboratories of Canada (ULC)

#### 1.3 SYSTEM DESCRIPTION

- A. Design Requirements
  - 1. Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
  - 2. Base maximum load ratings on allowable stresses prescribed by MSS SP58 or ASME B31.1.

- 3. Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- 4. Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- 5. Provide for vertical adjustments after erection and during commissioning. Amount of adjustment to be in accordance with MSS SP58.
- B. Performance Requirements
  - 1. Design supports, platforms, catwalks, hangers, to withstand seismic events for location as per the National Building Code

# 1.4 SUBMITTALS

- A. Submittals: in accordance with Section 01 33 00 Submittal Procedures.
- B. Shop drawings: submit drawings stamped and signed for approval by Owner's Representative.
- C. Submit shop drawings and product data for following items:
  - 1. Bases, hangers and supports.
  - 2. Connections to equipment and structure.
  - 3. Structural assemblies.
- D. Quality assurance submittals: submit following in accordance with Section 01 33 00 Submittal Procedures.
  - 1. Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - 2. Instructions: submit manufacturer's installation instructions.
    - a. Owner's Representative will make available 1 copy of systems supplier's installation instructions.
- E. Closeout Submittals:
  - 1. Provide maintenance data for incorporation into manual specified in Section 01 78 00 Closeout Submittals

# 1.5 QUALITY ASSURANCE

- A. Health and Safety:
  - 1. Do construction occupational health and safety in accordance with Section 01 35 29.06 Health and Safety Requirements.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packing, shipping, handling and unloading:
  - 1. Deliver, store and handle in accordance with Section 01 61 00 Common Product Requirements.
  - 2. Deliver, store and handle materials in accordance with manufacturer's written instructions.
- B. Waste Management and Disposal:
  - 1. Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 Construction/Demolition Waste Management and Disposal.

# PART 2 - PRODUCTS

# 2.1 GENERAL

A. Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP-58 and SP-89.

# 2.2 PIPE HANGERS

- A. Finishes:
  - 1. Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.
  - 2. Use electro-plating galvanizing process or hot dipped galvanizing process.
  - 3. Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- B. Upper attachment structural: Suspension from lower flange of I-Beam.
  - 1. Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - a. Rod: 9 mm UL listed, 13 mm FM approved.
  - 2. Cold piping NPS 2 1/2 or greater, hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed, FM approved where required to MSS-SP58 and MSS-SP69.
- C. Upper attachment structural: Suspension from upper flange of I-Beam.
  - 1. Cold piping NPS 2 maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved where required to MSS SP69.
  - 2. Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed, FM approved where required.

- D. Upper attachment to concrete.
  - 1. Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - 2. Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved where required to MSS SP-69.
- E. Shop and field-fabricated assemblies.
  - 1. Trapeze hanger assemblies: MSS SP-89.
  - 2. Steel brackets: MSS SP-89.
  - 3. Sway braces for seismic restraint systems: to MSS SP-89.
- F. Hanger rods: threaded rod material to MSS SP-58.
  - 1. Ensure that hanger rods are subject to tensile loading only.
  - 2. Provide linkages where lateral or axial movement of pipework is anticipated.
  - 3. Do not use 22 mm or 28 mm rod.
- G. Pipe attachments: material to MSS SP-58.
  - 1. Attachments for steel piping: carbon steel galvanized.
  - 2. Attachments for copper piping: copper plated black steel.
  - 3. Use insulation saddles for hot pipework.
  - 4. Oversize pipe hangers and supports for insulated pipes.
- H. Adjustable clevis: material to MSS SP-69, UL listed FM approved, where required clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - 1. Ensure "U" has hole in bottom for rivetting to insulation shields.
- I. Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-69.
- J. U-bolts: carbon steel to MSS SP-69 with 2 nuts at each end to ASTM A563.
  - 1. Finishes for steel pipework: galvanized.
  - 2. Finishes for copper, glass, brass or aluminum pipework: black with formed portion plastic coated or epoxy coated.
- K. Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-69.

### 2.3 RISER CLAMPS

- A. Steel or cast iron pipe: galvanized black carbon steel to MSS SP-58, type 42, UL listed FM approved where required.
- B. Copper pipe: carbon steel copper plated to MSS SP-58, type 42.
- C. Bolts: to ASTM A307.
- D. Nuts: to ASTM A563.

#### HANGERS AND SUPPORTS FOR HVAC

## 2.4 INSULATION PROTECTION SHIELDS

- A. Insulated cold piping:
  - 1. 64 kg/m<sup>3</sup> density insulation plus insulation protection shield to: MSS SP-69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- B. Insulated hot piping:
  - 1. Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP-69.

## 2.5 CONSTANT SUPPORT SPRING HANGERS

- A. Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- B. Load adjustability: 10 % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- C. Provide upper and lower factory set travel stops.
- D. Provide load adjustment scale for field adjustments.
- E. Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- F. Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

#### 2.6 VARIABLE SUPPORT SPRING HANGERS

- A. Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- B. Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- C. Variable spring hanger to be complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
- D. Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

### 2.7 EQUIPMENT SUPPORTS

A. Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

# 2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

A. Provide templates to ensure accurate location of anchor bolts.

# 2.9 HOUSE-KEEPING PADS

- A. For base-mounted equipment: Concrete, at least 100 mm high, 50 mm larger all around than equipment, and with chamfered edges.
- B. Concrete: to Section 03 30 00 Cast-in-place Concrete by Division 3.

# 2.10 OTHER EQUIPMENT SUPPORTS

- A. From structural grade steel meeting requirements of Section 05 12 23 Structural Steel for Buildings.
- B. Submit structural calculations with shop drawings.

# PART 3 - EXECUTION

# 3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

# 3.2 INSTALLATION

- A. Install in accordance with:
  - 1. Manufacturer's instructions and recommendations.
- B. Vibration Control Devices:
  - 1. Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere as indicated.
- C. Clamps on riser piping:
  - 1. Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

#### HANGERS AND SUPPORTS FOR HVAC

- 2. Bolt-tightening torques to be to industry standards.
- 3. Steel pipes: Install below coupling or shear lugs welded to pipe.
- 4. Cast iron pipes: Install below joint.
- D. Clevis plates:
  - 1. Attach to concrete with 4 minimum concrete inserts, one at each corner.
- E. Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- F. Use approved constant support type hangers where:
  - 1. Vertical movement of pipework is 13 mm or more,
  - 2. Transfer of load to adjacent hangers or connected equipment is not permitted.
- G. Use variable support spring hangers where:
  - 1. Transfer of load to adjacent piping or to connected equipment is not critical.
  - 2. Variation in supporting effect does not exceed 25 % of total load.

#### 3.3 HANGER SPACING

- A. Plumbing piping: most stringent requirements of Canadian Plumbing Code
- B. Fire protection: to applicable fire code.
- C. Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- D. Copper piping: up to NPS 1/2: every 1.5 m.
- E. Hydronic, steam, condensate, rigid, and flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

Maximum Pipe Size: NPS	Maximum Spacing: Steel	Maximum Spacing: Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 m	

- F. Within 300 mm of each elbow.
- G. Pipework greater than NPS 12: to MSS SP69.

# 3.4 HANGER INSTALLATION

- A. Install hanger so that rod is vertical under operating conditions.
- B. Adjust hangers to equalize load.
- C. Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members, comprised of angel iron or c-channel.

# 3.5 HORIZONTAL MOVEMENT

- A. Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- B. Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

# 3.6 FINAL ADJUSTMENT

- A. Adjust hangers and supports:
  - 1. Ensure that rod is vertical under operating conditions.
  - 2. Equalize loads.
- B. Adjustable clevis:
  - 1. Tighten hanger load nut securely to ensure proper hanger performance.
  - 2. Tighten upper nut after adjustment.
- C. C-clamps:
  - 1. Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- D. Beam clamps:
  - 1. Hammer jaw firmly against underside of beam.

# SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

# 1.1 SECTION REQUIREMENTS

- A. Submittals:
  - 1. Product Data: For each product indicated.
  - 2. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 3. Welding certificates.

### PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
  - 1. Basic Wind Speed: 100 MPa.
  - 2. Building Classification Category: III.
  - 3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: E.
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
    - a. Component Importance Factor: To be determined from ASCE 07-10, Section 13.1.1 for each component type.
    - b. Component Response Modification Factor: To be determined from ASCE 07-10, Table 13.6-1 for each component type.
    - c. Component Amplification Factor: To be determined from ASCE 07-10, Table 13.6-1 for each component type.
  - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second):  $S_DS = 0.437g$  (43.7%).
  - 4. Design Spectral Response Acceleration at 1-Second Period:  $S_D1 = 0.233g(23.3\%)$ .
- D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."

# 2.2 VIBRATION ISOLATORS

- A. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
  - 1. Resilient Material: Oil- and water-resistant neoprene.
- B. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
  - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridgebearing neoprene as defined by AASHTO.
- C. Restrained Mounts: All-directional mountings with seismic restraint.
  - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridgebearing neoprene as defined by AASHTO.
- D. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
  - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
  - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- E. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
  - 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. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- F. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- G. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
  - 1. 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.
  - 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. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  - 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- H. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene verticallimit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

# 2.3 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with 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; and rated in tension, compression, and torsion forces.
- C. Restraint Cables: ASTM A 603 galvanized- steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

- 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. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- F. Mechanical Anchor Bolts: 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 required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

# PART 3 - EXECUTION

# 3.1 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
  - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- E. 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.
- F. Drilled-in 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 the 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 Anchors: 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
## 3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.

## 3.3 ADJUSTING

- A. Adjust isolators after piping 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 active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

# 3.4 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

- A. Supported or Suspended Equipment: Fan coils, duct, hydronic piping
  - 1. Equipment Location
  - 2. Base Type: Cables.
  - 3. Component Importance Factor: 1.25.
  - 4. Component Response Modification Factor: 2.5.
  - 5. Component Amplification Factor: 2.5.

END OF SECTION 230548

# SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Related Documents:
  - 1. Drawings and general provisions of the Subcontract apply to this Section.
  - 2. Review these documents for coordination with additional requirements and information that apply to work under this Section.
- B. Section Includes:
  - 1. Identify all installed mechanical distribution piping, mechanical equipment and components.
  - 2. Cast-in-place concrete.
- C. Related Sections:
  - 1. Division 01 Section "General Requirements."
  - 2. Division 01 Section "Special Procedures."
  - 3. Division 09 Section "Painting" for identification painting.

## 1.2 REFERENCES

- A. General:
  - 1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
  - 2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
  - 3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.
  - 4. Refer to Division 23 Section "Common Results for HVAC" for codes and standards, and other general requirements.
- B. ANSI/ASME American National Standards Institute/Society of Mechanical Engineers:
  - 1. ASNI/ASME A 13.1 Scheme for the identification of piping systems

### 1.3 SUBMITTALS

A. Submit under provisions of Division 23 Section "Common Results for HVAC, Review of Materials" and Division 01 Section "General Requirements."

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- B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Submit valve database as per Part 3.05 -Stenciling and Identification, D.3 Valve Tags.

# PART 2 - PRODUCTS

# 2.1 ACCEPTABLE MANUFACTURERS

- A. W. H. Brady, Seton or Almatek products.
- B. No substitutions.

# 2.2 MATERIALS

- A. Color coding: ANSI/ASME A13.1 unless specified otherwise.
- B. Plastic nameplates: laminated two-layer plastic with engraved black letters on light, contrasting background color.
- C. Plastic tags: laminated three-layer (double-sided) plastic with engraved black letters on light, contrasting background color. Tag size at least 1-1/2 inch (38 mm) diameter.
- D. Stencils: with clean-cut symbols and letters of following size:

Outside Diameter of Insulation or Pipe	Color Field Length	Letter Height
$\frac{3}{4}$ to 1-1/4 inches (9.5 to 31.7 mm)	8 inches (200 mm)	$\frac{1}{2}$ inch (13 mm)
1 1/2 to 2 inches (22 1 to 50 2 mm)	8 in shee (200 mm)	3/ in sh (20 mm)
1-1/2 to 2 inches (38.1 to 50.8 mm)	8 inches (200 mm)	<sup>3</sup> /4 Inch (20 mm)
2-1/2 to 2 inches (63.5 to 50.8 mm)	12 inches (300 mm)	1 ¼ inch (32 mm)
8 to 10 inches (203.2 to 254 mm)	24 inches (600 mm)	2 <sup>1</sup> / <sub>2</sub> inch (64 mm)
Over 10 inches (254 mm)	32 inches (800 mm)	3 inches (75 mm)
Ductwork and equipment		2 ½ inch (64 mm)

- E. Stencil paint: semi-gloss enamel; in accordance with Division 09 Section "Painting".
- F. Plastic pipe markers: factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.

- 1. Special gases shall be identified using markers with yellow background and black letters, direction arrow, and full chemical names and symbols.
- G. Plastic-tape pipe markers: flexible, vinyl-film tape with pressure-sensitive adhesive backing and printed markings.
- H. Equipment tags: Metal tags, Almetek TH-9A with 500-series consisting of Almetek industries 9-character aluminum holder #TH-9A with 500-series characters, black on yellow background. Format is 2 characters for building # (15), space, 2 or 3 characters for equipment type (AC, AHU, etc.), space, three-digit equipment number (001, etc.). These tags can be ordered in parts and site-assembled, or pre-assembled from the factory. Attachment is by a pair of rivets, screws, or bolts onto the equipment to be identified; for water meters and similar equipment installed in piping, a pair of chains can be used for attachment.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive of identification materials.
- B. Prepare surfaces in accordance with Division 09 Section "Painting" for stencil painting.

## 3.2 INSTALLATION

- A. Plastic nameplates: install with corrosion-resistant mechanical fasteners, or adhesive.
- B. Plastic tags: install with corrosion-resistant chain.
- C. Stencil painting: apply in accordance with Division 09 Section "Painting".
- D. Plastic pipe markers: install in accordance with manufacturer's instructions.
- E. Plastic-tape pipe markers: install completely around pipe in accordance with manufacturer's instructions.
- F. Underground plastic pipe markers: install 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
- G. Equipment tags: Install with corrosion-resistant mechanical fasteners.

## 3.3 IDENTIFICATION SCHEDULE

A. Equipment: identify air-handling units, pumps, heat-transfer equipment, tanks, boilers, blowers, and water-treatment devices, etc (see mechanical and plumbing schedules) with equipment tags per Section 2.2H. Small devices, such as VAV boxes and VFD's, may be identified with plastic tags.

- B. Controls: identify control panels and major control components outside of panels with plastic nameplates.
- C. Valves: identify valves in main and branch piping with tags.
- D. Piping: identify piping, concealed or exposed, with stenciled painting. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not more than 20 feet (6 m) apart on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- E. Ductwork: identify ductwork with stenciled painting. Identify as to air-handling unit number, and area served. Locate identification at air-handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

## 3.4 VALVE DATABASE

A. Provide specified valve database.

## 3.5 STENCILING AND IDENTIFICATION

- A. Stencil each piece of new and existing equipment including pumps, fans, tanks, etc., with the equipment tags scheduled on the drawings and per Part 2 above.
  - 1. Stencil each duct leaving the mechanical room indicating fan unit, area(s), direction of flow, or room(s) served.
  - 2. Stencil each duct branch leaving an air shaft at each floor with fan number, and identify it as a supply, exhaust, or return duct, and indicate direction of air flow.
- B. Post a framed and typewritten schedule of all stencils, pipe markers, and valve tags, used, with identification, shall be framed and posted in the mechanical equipment room.
- C. Identify all pipes with specified markers.
  - 1. Install markers every 10 feet (3 m) on mains, at all branch take-offs and adjacent to valves and cocks.
  - 2. Apply to all exposed pipes, pipes behind removable tile ceiling, pipes in concealed but accessible locations, such as behind access panels and at least once in each room.
  - 3. Install pipe marker using pressure sensitive adhesive in accordance with the manufacturer's directions. The marker shall completely cover the circumference of the pipe and overlap itself.
- D. Valve Tags: Provide numbered tags for main valves, branch valves, zone valves, shut-off valves, and balancing valves installed under this Contract, constructed of #18 gauge (1.02 mm) brass, circular, 1 ¼ inches (31.7 mm) in diameter, and with numbers cut in and blackened so as to be plainly discernible. Fasten tags to valve with brass links.
  - 1. Valve numbers not required for valves obviously serving equipment such as air handler coils, reheat coil valves, and miscellaneous drains.

- 2. On the as-built drawings, indicate the location and number of each tagged valve.
- 3. Provide a computer file database in a form agreeable to the University, describing the valve, number, location, type of service normally "open" or "closed", specific duty of each tagged valve, and manufacturer and model number.
- E. Warning Sign at Fume Exhaust Plenums: Place warning sign on each fume exhaust plenum access "WARNING. HAZARDOUS ATMOSPHERE INSIDE. USE BREATHING APPARATUS" when breaching containment.
- F. Place warning signs on all machines driven by electric motors which are controlled by fully automatic starters. See Section 3320, Article 7, Subchapter 7, General Industry Safety Orders, Title 8, California Code of Regulations.
- G. Fire dampers and fire smoke dampers: at each fire damper or fire smoke damper access panel, label "FIRE DAMPER" or "FIRE SMOKE DAMPER" in minimum 1 inch (25 mm) high letters. Fire smoke dampers shall be provided with tags to identify each fire smoke dampers with 2 lines as follows: the first line "FSD-NUMBER SEQUENCES-BLDG NUMBER" (e.g. FSD-001-15). The second line "ZONE FIRE ALARM-zone" that activates the damper (e.g. ZONE L1-03). Tags shall be engraved plastic with white letters on red background. Provide chart to University for approval.
- H. Wherever charts, Shop Drawings, etc. Refer to specific room numbers, use room numbers that will be provided by the university rather than the room numbers indicated on the Drawings.

## END OF SECTION 230553

# SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-flow air systems.
- B. Contractor shall balance/re-balance all new VAV boxes and all existing VAV boxes, which required ductwork modifications. Existing VAV boxes that remain in place, without ductwork modifications do not require balancing/re-balancing.

### 1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

### 1.3 SUBMITTALS

A. Certified TAB reports.

### 1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

- 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Architect and Commissioning Authority.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- E. All balancing shall be compliant with MN IMC 1346.309.
- F. All startup and testing shall be compliant with MN IMC 107.2.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  - 1. Certified TAB reports.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" Section 233116 "Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

- 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, 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 operating safety interlocks and controls on HVAC equipment.
- L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

# 3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
  - 1. Permanent electrical-power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance, smoke, and fire dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

#### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. ASHRAE 62.1-2004 requires that ventilation systems be balanced according to ASHRAE 111, SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," or equivalent at least to extent necessary to verify compliance with the standard.

- B. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- D. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- E. Take and report testing and balancing measurements in inch-pound (IP) units.

## 3.4 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 flows with required fan flows.
- B. Create schematic diagrams of each air systems' sections showing measurement locations.
- 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. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

- 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
- 3. Measure static pressures entering and leaving other devices, such as sound traps, heatrecovery equipment, and air washers, under final balanced conditions.
- 4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- K. Adjust volume dampers for main duct, sub main ducts, and major branch ducts to indicated airflows within specified tolerances.
- L. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
  - 1. Adjust patterns of adjustable outlets for proper distribution without drafts.

# 3.5 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. Efficiency rating.
  - 5. Nameplate and measured voltage, across each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.
  - 1. Measure flow through bypass.

## 3.6 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data

## 3.7 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  - 2. Air Outlets and Inlets: Plus or minus 10 percent.

### 3.8 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: 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. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.9 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 cur rent calibration.
- B. Schedule:
  - 1. Submit preliminary test and balance report to Engineer at least one week prior to Owner training for installed equipment.
  - 2. Submit certified test and balance report(s) to be bound into or included with delivery of Owner's Operation and Maintenance manuals.
- C. Contents: In addition to certified field-report data, include the following:
  - 1. Pump curves.
  - 2. Fan curves.
  - 3. Field test and start-up reports prepared by system and equipment installers.
- D. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB contractor.
  - 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 and pump 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. Face and bypass damper settings at coils.
  - e. Fan drive settings including settings and percentage of maximum pitch diameter.
  - f. Inlet vane settings for variable-air-volume systems.
  - g. Settings for supply-air, static-pressure controller.
  - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  - 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.
  - 3. Duct, outlet, and inlet sizes.
  - 4. Pipe and valve sizes and locations.
  - 5. Terminal units.
  - 6. Balancing stations.
  - 7. Position of balancing devices.
- F. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
  - 1. Quantities of outdoor, supply, return, and exhaust airflows.
  - 2. Water and steam flow rates.
  - 3. Duct, outlet, and inlet sizes.
  - 4. Pipe and valve sizes and locations.
  - 5. Terminal units.
  - 6. Balancing stations.
  - 7. Position of balancing devices.

# 3.10 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 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 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 Sections:
  - 1. Section 230716 "HVAC Equipment Insulation."
  - 2. Section 230719 "HVAC Piping Insulation."
  - 3. Section 233113 "Metal Ducts" for duct liners.

## 1.3 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).

# 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.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 or UL 723, 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.

- 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
- 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with 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.

## PART 2 - PRODUCTS

#### 2.1 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 shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
  - 1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

- 2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
- 3. All fitting must be must be factory fabricated, not field fabricated fitting allowed.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type I and Type II and ASTM C 1290, Type III with factoryapplied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. CertainTeed Corp.; Commercial Board.
    - b. Fibrex Insulations Inc.; FBX.
    - c. Johns Manville; 800 Series Spin-Glas.
    - d. Knauf Insulation; Insulation Board.
    - e. Manson Insulation Inc.; AK Board.
    - f. Owens Corning; Fiberglas 700 Series.

### 2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. K-Flex USA.
  - 2. Adhesives shall have a VOC content of 50 g/L or less.
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of

Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- C. Mineral-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 Construction Products.
    - d. Mon-Eco Industries, Inc.
  - 2. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Manufacturers: Subject to compliance with requirements, 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 Construction Products.
    - d. Mon-Eco Industries, Inc.
  - 2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Dow Corning Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. P.I.C. Plastics, Inc.
  - 2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. VOC Content: 300 g/L or less.
- B. Vapor-Barrier 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. Foster Brand; H. B. Fuller Construction Products.
  - b. Knauf Insulation.
  - c. Vimasco Corporation.
- 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 180 deg F.
- 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
- 5. Color: White.

## 2.4 SEALANTS

- A. FSK and 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 Construction Products.
    - d. Mon-Eco Industries, Inc.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 5. Color: Aluminum.
  - 6. Sealant shall have a VOC content of 420 g/L or less.

## 2.5 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 C 1136, Type I.
  - 2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  - 3. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
  - 4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. 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. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Proto Corporation.
    - d. Speedline Corporation.
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: White jackets based on system.
- D. Outdoor Jacket: 45-mil-thick, polyester-reinforced DPDM roofing membrane, white.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Johns Manville; a Berkshire Hathaway company.

## 2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.
    - e. Venture Tape.
  - 2. Width: 3 inches.
  - 3. Thickness: 11.5 mils.
  - 4. Adhesion: 90 ounces force/inch in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: 40 lbf/inch in width.
  - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.

- e. Venture Tape.
- 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.

## 2.8 SECUREMENTS

- A. Bands:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.
    - b. RPR Products, Inc.
  - 2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
  - 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) AGM Industries, Inc.
      - 2) Gemco.
      - 3) Midwest Fasteners, Inc.
    - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - c. Spindle: Aluminum or stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
    - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  - 2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Gemco.
- 2) Midwest Fasteners, Inc.
- b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
- c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
- d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Hardcast, Inc.
    - 4) Midwest Fasteners, Inc.
  - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Aluminum or stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
- 4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel, aluminum, or stainless-steel] sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Hardcast, Inc.
    - 4) Midwest Fasteners, Inc.
    - 5) Nelson Stud Welding.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- 5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Gemco.

- 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, galvanized steel.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. C & F Wire.

### 2.9 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

### PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

## 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- 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.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Follow material stretch-out calculations.
  - 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 **2 inches** o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- 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 FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins when needed.
  - 1. Blanket shall be cut to "stretch-out" dimensions defined by stretch-out with 2 inch (approx.) piece of insulation is removed from the facing at the end of the stretch-out piece of duct wrap to form an overlapping staple and tape flap.
  - 2. Install the duct wrap tightly butted with facing on the outside. Overlap the 2 inch formed tape flap and facing at other end of the piece of duct wrap. If ducts are rectangular or square, install so insulation is not excessively compressed at duct corners. Seams shall be stapled approximately 6 inch (approx.) on center with outward clinching staples, or with three or four evenly spaced tape tabs.
  - 3. Adjacent sections of duct wrap shall be tightly butted with the factory 2 inch tape flap overlapping the adjoining duct wrap section. In the event that the factory tape flap has been removed, reinstall the 2 inch tape flap.
  - 4. Where a vapor retarder is required, seal all seams and joints with pressure-sensitive tape matching the facing (either plain foil or FRK backing stock) or with glass fabric and mastic. Cloth duct tape of any color and finish using reclaimed rubber adhesives is not recommended for use on SOFTRR Duct Wrap FRK.
  - 5. When needed install either capacitor-discharge-weld pins and speed washers or cuppedhead, capacitor-discharge-weld pins on the 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 and side surfaces 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.
  - 6. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vaporbarrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

- 7. 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.
- 8. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 9. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitordischarge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not overcompress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vaporbarrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
  - 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

# 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  - 2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
  - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  - 1. Draw jacket material smooth and tight.
  - 2. Install lap or joint strips with same material as jacket.
  - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
  - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

## 3.8 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and 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 or stainless-steel 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 shall be limited to one location 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, Type I, commercial, kitchen hood exhaust.
  - 6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
  - 7. Indoor, concealed oven and warewash exhaust.
  - 8. Indoor, exposed oven and warewash exhaust.
  - 9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  - 10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
  - 11. Outdoor, concealed supply and return.
  - 12. Outdoor, exposed supply and return.
- B. Items Not Insulated:
  - 1. Fibrous-glass ducts.
  - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  - 3. Factory-insulated flexible ducts.
  - 4. Factory-insulated plenums and casings.
  - 5. Flexible connectors.
  - 6. Vibration-control devices.
  - 7. Factory-insulated access panels and doors.

#### 3.11 INDOOR DUCT AND INSULATION SCHEDULE

- A. Concealed supply and outdoor air duct shall be one of the following (minimum R-6):
  - 1. Mineral-Fiber Blanket: 1-1/2 inches thick.
  - 2. Mineral-Fiber Board: 1-1/2 inches thick.
- B. Exposed supply and outdoor air duct shall be one of the following (minimum R-6) (paintable):
  - 1. Mineral-Fiber Blanket: 1-1/2 inches thick.
  - 2. Mineral-Fiber Board: 1-1/2 inches thick.
- C. Return duct serving air-conditioned spaces that is installed in non-conditioned space shall be one of the following (minimum R-6):
  - 1. Mineral-Fiber Blanket: 1-1/2 inches thick.
  - 2. Mineral-Fiber Board: 1-1/2 inches thick.
- D. Exhaust duct, within 10 ft of wall or roof penetration, shall be one of the following (minimum R-6):
  - 1. Mineral-Fiber Blanket: 1-1/2 inches thick.
  - 2. Mineral-Fiber Board: 1-1/2 inches thick.
- E. Refer to Section 233113 Metal Ducts for duct liner requirements.

## 3.12 OUTDOOR DUCT INSULATION SCHEDULE

- A. Supply, return, and outdoor air duct shall be one of the following (minimum R-6):
  - 1. Mineral-Fiber Board: 2 inches thick, wrapped with watertight EDPM roofing membrane outer jacket.

END OF SECTION 230713

# SECTION 230716 - HVAC EQUIPMENT INSULATION

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section includes insulating the following HVAC equipment that is not factory insulated:
  - 1. Chillers.
  - 2. Heat exchangers.
  - 3. Chilled-water pumps.
  - 4. Heating hot-water pumps.
  - 5. Expansion/compression tanks.
  - 6. Air separators.
  - 7. Thermal storage tanks.
  - 8. Piping system filtration unit housings.
- B. Related Sections:
  - 1. Section 230713 "Duct Insulation."
  - 2. Section 230719 "HVAC Piping Insulation."

#### 1.3 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 attachment and covering of heat tracing inside insulation.
  - 3. Detail removable insulation at equipment connections.
  - 4. Detail application of field-applied jackets.
  - 5. Detail application at linkages of control devices.
  - 6. Detail field application for each equipment type.

## 1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

### HVAC EQUIPMENT INSULATION

## 1.5 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 equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

## 1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

# PART 2 - PRODUCTS

# 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Pittsburgh Corning Corporation; Foamglas.
  - 2. Block Insulation: ASTM C 552, Type I.
  - 3. Special-Shaped Insulation: ASTM C 552, Type III.
  - 4. Board Insulation: ASTM C 552, Type IV.

- 5. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Sheet and K-FLEX LS.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- I. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Industrial Insulation Group (IIG); MinWool-1200 Flexible Batt.
    - b. Johns Manville; HTB 26 Spin-Glas.
    - c. Roxul Inc.; Roxul RW.
- J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation factory-applied ASJ, Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; CertaPro Commercial Board.
    - b. Fibrex Insulations Inc.; FBX.
    - c. Johns Manville; 800 Series Spin-Glas.
    - d. Knauf Insulation; Insulation Board.
    - e. Manson Insulation Inc.; AK Board.
    - f. Owens Corning; Fiberglas 700 Series.
- K. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

- 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
  - a. Fibrex Insulations Inc.; FBX.Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
  - b. Rock Wool; Delta Board.
  - c. Roxul Inc.; RHT and RockBoard.
  - d. Thermafiber, Inc.; Thermafiber Industrial Felt.
  - e. <Insert manufacturer's name; product name or designation>.
- L. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000-Degree Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.
- M. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg. F is 0.29 Btu x in./h x sq. ft. x deg. F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; CrimpWrap.
    - b. Johns Manville; MicroFlex.
    - c. Knauf Insulation; Pipe and Tank Insulation.
    - d. Manson Insulation Inc.; AK Flex.
    - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Ramco Insulation, Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Ramco Insulation, Inc.; Thermokote V.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

# 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA, Inc.; Aeroseal.
    - b. Armacell LLC; Armaflex 520 Adhesive.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    - d. K-Flex USA; R-373 Contact Adhesive.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. Mon-Eco Industries, Inc; 22-25.
  - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Corning Corporation; 739, Dow Silicone.
    - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
    - d. Speedline Corporation; Polyco VP Adhesive.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    - b. Eagle Bridges Marathon Industries; 501.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    - d. Mon-Eco Industries, Inc.; 55-10.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
  - 3. Service Temperature Range: 0 to 180 deg F.
  - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
  - 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
- b. Eagle Bridges Marathon Industries; 570.
- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
- 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
- 3. Service Temperature Range: Minus 50 to plus 220 deg F.
- 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
- 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    - b. Eagle Bridges Marathon Industries; 550.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. Vimasco Corporation; WC-1/WC-5.
  - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: 60 percent by volume and 66 percent by weight.
  - 5. Color: White.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  - 1. For indoor applications, use lagging adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    - c. Vimasco Corporation; 713 and 714.
  - 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
  - 4. Service Temperature Range: 0 to plus 180 deg. F.
  - 5. Color: White.

## 2.6 SEALANTS

- A. Joint Sealants:
  - 1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    - b. Eagle Bridges Marathon Industries; 405.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Pittsburgh Corning Corporation; Pittseal 444.
  - 2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
    - b. Eagle Bridges Marathon Industries; 405.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    - d. Mon-Eco Industries, Inc.; 44-05.
  - 3. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 4. Permanently flexible, elastomeric sealant.
  - 5. Service Temperature Range: Minus 100 to plus 300 deg. F.
  - 6. Color: White or gray.
  - 7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. FSK and Metal Jacket Flashing Sealants:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    - b. Eagle Bridges Marathon Industries; 405.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    - d. Mon-Eco Industries, Inc.; 44-05.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.

- 4. Service Temperature Range: Minus 40 to plus 250 deg. F.
- 5. Color: Aluminum.
- 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg. F.
  - 5. Color: White.
  - 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
  - 5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
    - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

- 6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
  - a. Products: Subject to compliance with requirements, [available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

#### 2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. in a Leno weave, for equipment.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
    - b. Vimasco Corporation; Elastafab 894.

# 2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

## 2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: White
  - 4. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    - c. RPR Products, Inc.; Insul-Mate.
  - 2. Aluminum Jacket: Comply with ASTM B 209 Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Sheet and roll stock ready for shop or field sizing.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    - d. Moisture Barrier for Outdoor Applications: 3-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 fabricated fitting covers only if factory-fabricated fitting covers are not available.
- E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Polyguard Products, Inc.; Alumaguard 60.
- F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
- G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560

# 2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  - 2. Width: 3 inches.
  - 3. Thickness: 11.5 mils.
  - 4. Adhesion: 90 ounces force/inch in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: 40 lbf/inch in width.
  - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 491 AWF FSK.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - c. Compac Corporation; 110 and 111.
    - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  - 2. Width: 3 inches
  - 3. Thickness: 6.5 mils.
  - 4. Adhesion: 90 ounces force/inch in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: 40 lbf/inch in width.
  - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.
  - 2. Width: 2 inches.
  - 3. Thickness: 6 mils.
  - 4. Adhesion: 64 ounces force/inch in width.

- 5. Elongation: 500 percent.
- 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 488 AWF.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - c. Compac Corporation; 120.
    - d. Venture Tape; 3520 CW.
  - 2. Width: 2 inches
  - 3. Thickness: 3.7 mils.
  - 4. Adhesion: 100 ounces force/inch in width.
  - 5. Elongation: 5 percent.
  - 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
  - 2. Width: 3 inches.
  - 3. Film Thickness: 4 mils.
  - 4. Adhesive Thickness: 1.5 mils.
  - 5. Elongation at Break: 145 percent.
  - 6. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
  - 2. Width: 3 inches.
  - 3. Film Thickness: 6 mils.
  - 4. Adhesive Thickness: 1.5 mils.
  - 5. Elongation at Break: 145 percent.
  - 6. Tensile Strength: 55 lbf/inch in width.

#### 2.12 SECUREMENTS

- A. Bands:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. ITW Insulation Systems; Gerrard Strapping and Seals.
- b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
- 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
- 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
  - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.
    - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) AGM Industries, Inc.; CWP-1.
      - 2) GEMCO; CD.
      - 3) Midwest Fasteners, Inc.; CD.
      - 4) Nelson Stud Welding; TPA, TPC, and TPS.
  - 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
    - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) AGM Industries, Inc.; CHP-1.
      - 2) GEMCO; Cupped Head Weld Pin.
      - 3) Midwest Fasteners, Inc.; Cupped Head.
      - 4) Nelson Stud Welding; CHP.
  - 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
    - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      - 2) GEMCO; Perforated Base.
      - 3) Midwest Fasteners, Inc.; Spindle.
    - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - c. Spindle: Copper- or zinc-coated, low-carbon steel fully annealed, 0.106-inchdiameter shank, length to suit depth of insulation indicated.

- d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- 4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 1) AGM Industries, Inc.; RC-150.
    - 2) GEMCO; R-150.
    - 3) Midwest Fasteners, Inc.; WA-150.
    - 4) Nelson Stud Welding; Speed Clips.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. C & F Wire

#### 2.13 CORNER ANGLES

- A. PVC Corner Angles: 30 thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209 ,Alloy 3003, 3005, 3105, or 5005; Temper H-14.

## 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 and equipment 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.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils) thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg. F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Cat carbon steel operating at a service temperature between 32 and 300 deg. F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.
- D. 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 equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at 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.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.

- 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
- 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- 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.
  - 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 2 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- 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.
- O. For above ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

## 3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

- 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
- 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
- 3. Protect exposed corners with secured corner angles.
- 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
  - a. Do not weld anchor pins to ASME-labeled pressure vessels.
  - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
  - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
  - d. Do not overcompress insulation during installation.
  - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
  - f. Impale insulation over anchor pins and attach speed washers.
  - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
- 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
- 7. Stagger joints between insulation layers at least 3 inches.
- 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
- 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
- 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
  - 1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
  - 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:

- 1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
- 2. Fabricate boxes from galvanized steel, at least 0.050 inch] thick.
- 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

# 3.5 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
  - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  - 1. Draw jacket material smooth and tight.
  - 2. Install lap or joint strips with same material as jacket.
  - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
  - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:
  - 1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
  - 2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

## 3.6 FINISHES

- A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and 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 or stainless-steel jackets.

## 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

## 3.8 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.
- C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:
  - 1. Cellular Glass: 2 inches thick.
  - 2. Flexible Elastomeric: 1 inch thick.
  - 3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
- D. Chilled-water pump insulation shall be one of the following:

- 1. Cellular Glass: 3 inches thick.
- 2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- E. Heating-hot-water pump insulation shall be one of the following:
  - 1. Cellular Glass: 1-1/2 inches thick.
  - 2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- F. Chilled-water expansion/compression tank insulation shall be one of the following:
  - 1. Cellular Glass: 1-1/2 inches thick.
  - 2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
- G. Heating-hot-water expansion/compression tank insulation shall be one of the following:
  - 1. Cellular Glass: 1-1/2 inches thick.
  - 2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
- H. Chilled-water air-separator insulation shall be one of the following:
  - 1. Cellular Glass: 2 inches thick.
  - 2. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Pipe and Tank: 1 inch thick.
- I. Heating-hot-water air-separator insulation shall be one of the following:
  - 1. Cellular Glass: 3 inches thick.
  - 2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Pipe and Tank: 2 inches thick.
- J. Piping system filter-housing insulation shall be one of the following:
  - 1. Cellular Glass: 3 inches thick.
  - 2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Pipe and Tank: 2 inches thick.

# 3.9 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. Equipment, Concealed:
  - 1. None.
- D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

- 1. None.
- E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
  - 1. None.

# 3.10 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. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
  - 1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.
- D. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
  - 1. Aluminum, Smooth with 4-by-1-Inch Box Ribs: 0.032 inch thick.

# END OF SECTION 230716

# SECTION 230719 - HVAC PIPING INSULATION

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
  - 1. Condensate drain piping, indoors and outdoors.
  - 2. Chilled-water piping, indoors and outdoors.
  - 3. Heating hot-water piping, indoors and outdoors.
  - 4. Steam and steam condensate piping, indoors and outdoors.
  - 5. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
  - 1. Section 230713 "Duct Insulation."
  - 2. Section 230716 "HVAC Equipment Insulation."

## 1.3 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 attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.5 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.
- C. Coordinate installation and testing of heat tracing.

# 1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

# PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Pittsburgh Corning Corporation; Foamglas.

- 2. Block Insulation: ASTM C 552, Type I.
- 3. Special-Shaped Insulation: ASTM C 552, Type III.
- 4. Board Insulation: ASTM C 552, Type IV.
- 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
- 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
- 7. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- I. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000-Degree Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.
- J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. CertainTeed Corp.; CrimpWrap.
- b. Johns Manville; MicroFlex.
- c. Knauf Insulation; Pipe and Tank Insulation.
- d. Manson Insulation Inc.; AK Flex.
- e. Owens Corning; Fiberglas Pipe and Tank Insulation.
- K. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Ramco Insulation, Inc.; Super-Stik.
- L. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Ramco Insulation, Inc.; Thermokote V.
- M. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

#### 2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Aeroflex USA, Inc.; Aeroseal.
- b. Armacell LLC; Armaflex 520 Adhesive.
- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
- d. K-Flex USA; R-373 Contact Adhesive.
- 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    - d. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Dow Corning Corporation; 739, Dow Silicone.
  - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
  - c. P.I.C. Plastics, Inc.; Welding Adhesive.
  - d. Speedline Corporation; Polyco VP Adhesive.
- 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
    - b. Eagle Bridges Marathon Industries; 501.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
    - d. Mon-Eco Industries, Inc.; 55-10.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.

- 3. Service Temperature Range: 0 to 180 deg F.
- 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
- 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
    - b. Eagle Bridges Marathon Industries; 570.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
  - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  - 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    - b. Eagle Bridges Marathon Industries; 550.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. Vimasco Corporation; WC-1/WC-5.
  - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: 60 percent by volume and 66 percent by weight.
  - 5. Color: White.

## 2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  - 1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.

- b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
- c. Vimasco Corporation; 713 and 714.
- 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: 0 to plus 180 deg F.
- 5. Color: White.

## 2.5 SEALANTS

- A. Joint Sealants:
  - 1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    - b. Eagle Bridges Marathon Industries; 405.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Pittsburgh Corning Corporation; Pittseal 444.
  - 2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
    - b. Eagle Bridges Marathon Industries; 405.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    - d. Mon-Eco Industries, Inc.; 44-05.
  - 3. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 4. Permanently flexible, elastomeric sealant.
  - 5. Service Temperature Range: Minus 100 to plus 300 deg F.
  - 6. Color: White or gray.
  - 7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. FSK and Metal Jacket Flashing Sealants:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
- b. Eagle Bridges Marathon Industries; 405.
- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
- d. Mon-Eco Industries, Inc.; 44-05.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: Aluminum.
- 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
  - 3. Fire- and water-resistant, flexible, elastomeric sealant.
  - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
  - 5. Color: White.
  - 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.6 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 C 1136, Type I.
  - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
  - 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

#### 2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz. /sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
    - b. Vimasco Corporation; Elastafab 894.

#### 2.8 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz. /sq. yd.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

#### 2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  - 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, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- D. Metal Jacket:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    - c. RPR Products, Inc.; Insul-Mate.
  - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Sheet and roll stock ready for shop or field sizing.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: [3-mil- thick, heat-bonded polyethylene and kraft paper.
    - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    - e. Factory-Fabricated Fitting Covers:
      - 1) Same material, finish, and thickness as jacket.
      - 2) Preformed 2-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.
- E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Pittsburgh Corning Corporation; Pittwrap.
    - b. Polyguard Products, Inc.; Insulrap No Torch 125.
- F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a

rubberized bituminous resin on a crosslaminated polyethylene film covered with [white] [stucco-embossed] aluminum-foil facing.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Polyguard Products, Inc.; Alumaguard 60.

#### 2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  - 2. Width: 3 inches
  - 3. Thickness: 11.5 mils
  - 4. Adhesion: 90 ounces force/inch in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: 40 lbf/inch in width.
  - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 491 AWF FSK.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - c. Compac Corporation; 110 and 111.
    - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  - 2. Width: 3 inches
  - 3. Thickness: 6.5 mils
  - 4. Adhesion: 90 ounces force/inch in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: 40 lbf/inch in width.
  - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. ABI, Ideal Tape Division; 370 White PVC tape.
  - b. Compac Corporation; 130.
  - c. Venture Tape; 1506 CW NS.
- 2. Width: 2 inches
- 3. Thickness: 6 mils
- 4. Adhesion: 64 ounces force/inch in width.
- 5. Elongation: 500 percent.
- 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 488 AWF.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - c. Compac Corporation; 120.
    - d. Venture Tape; 3520 CW.
  - 2. Width: 2 inches
  - 3. Thickness: 3.7 mils
  - 4. Adhesion: 100 ounces force/inch in width.
  - 5. Elongation: 5 percent.
  - 6. Tensile Strength: 34 lbf/inch in width.

## 2.11 SECUREMENTS

- A. Bands:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ITW Insulation Systems; Gerrard Strapping and Seals.
    - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
  - 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
  - 3. 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. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy.

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. C & F Wire.

## 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.
  - 3. 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.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. 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 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, soften, or otherwise attack insulation or jacket in either wet or dry state.
- 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive 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 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.
  - 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.
  - 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.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

## 3.4 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 Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: 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.
- F. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

## 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.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for

above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

- 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
  - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  - 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

# 3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
  - 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
  - 4. For insulation with factory-applied jackets on below-ambient services, 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 preformed pipe insulation to outer diameter of pipe flange.
- 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
- 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe 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 preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  - 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed sections of cellular-glass insulation to valve body.
  - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 3. Install insulation to flanges as specified for flange insulation application.

### 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with the manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install mitered sections of pipe insulation.
  - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.

- 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
- 3. Install insulation to flanges as specified for flange insulation application.
- 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.8 INSTALLATION OF MINERAL-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 factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
  - 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. 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 preformed 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 mineral-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 preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed 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 preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 4. Install insulation to flanges as specified for flange insulation application.

### 3.9 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  - 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
  - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  - 1. Draw jacket material smooth and tight.
  - 2. Install lap or joint strips with same material as jacket.
  - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
  - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with the manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

#### 3.10 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and 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 or stainless-steel jackets.

### 3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. 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 shall be 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.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.12 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.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.13 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Cellular Glass: 1/2 inches thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- B. Chilled Water, above 40 Deg F:
  - 1. NPS 1-1/4" and Smaller: Insulation shall be one of the following:
    - a. Cellular Glass: 1/2 inch thick.
    - b. Mineral-Fiber, Preformed Pipe, Type I: 1/2 inch thick.
  - 2. NPS 1-1/2" and Larger: Insulation shall be one of the following:
    - a. Cellular Glass: 1 inch thick.

- b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.
- C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
  - 1. NPS 1-1/4" and Smaller: Insulation shall be one of the following:
    - a. Cellular Glass: 1-1/2 inches thick.
    - b. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.
  - 2. NPS 1-1/2" and Larger: Insulation shall be one of the following:
    - a. Cellular Glass: 2 inches thick.
    - b. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
- D. Steam and Steam Condensate, 350 Deg F and Below:
  - NPS 1-1/4" and Smaller: Insulation shall be one of the following:
    a. Cellular Glass: 4 inches thick.
    - b. Mineral-Fiber, Preformed Pipe, Type I or II: 4 inches thick.
  - 2. NPS 1-1/2" and Larger: Insulation shall be one of the following:
    - a. Cellular Glass: 4-1/2 inches thick.
    - b. Mineral-Fiber, Preformed Pipe, Type I or II: 4-1/2 inches thick.
- E. Refrigerant Suction and Hot-Gas Piping:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- F. Refrigerant Suction and Hot-Gas Flexible Tubing:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1 inch thick.

### 3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Cellular Glass: 1 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
  - 1. All Pipe Sizes: Insulation shall be one of the following:

- a. Cellular Glass: 2 inches thick.
- b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- C. Steam and Steam Condensate, 350 Deg F and Below:
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Cellular Glass: 4-1/2 inches thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 4-1/2 inches thick.

### 3.15 UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill mechanical and waterproof protection insulation, for belowground piping, as indicated on drawings.

### 3.16 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. None.
- D. Piping, Exposed:
  - 1. None.

#### 3.17 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. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. PVC 30 mils thick.
  - 2. Aluminum, Smooth: 0.024 inch thick.
- D. Piping, Exposed:
  - 1. PVC: 40 mils thick.
  - 2. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch thick.

# 3.18 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried piping insulation material per manufacturers requirements.

END OF SECTION 230719

# SECTION 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

### 1.1 SUMMARY

- A. Provide for upgrade to existing temperature controls system, to new Schneider Ecosystem. Temperature Controls Contractor shall be Comfort Systems USA, Louisville, Kentucky. Contact Mike Fisher (502-363-2654).
- B. Temperature Controls Contractor shall be responsible for all electricals to their equipment/components.
- C. All variable frequency drives by Temperature Control Contractor. Refer to Section 262923.
- D. All HVAC temperature controls CAT-rated cabling shall be blue, to minimize confusion between other cable colors.
- E. Products furnished but not installed under this Section.
  - 1. Control Valves.
  - 2. Flow Switches.
  - 3. Temperature Sensor Wells and Sockets.
  - 4. Terminal Unit Controller (ASC).

#### 1.2 DEFINITIONS

- A. BACnet: Building Automation Control Network as defined in ASHRAE 135.
- B. BMS: Building Management System.
- C. DDC: Direct digital control.
- D. FC Bus: Field Controller Bus (Sub-network).
- E. I/O: Input/output.
- F. Internetwork: A two-tiered topology where building controllers and OWS operate as high speed network, and application specific controllers, custom application controllers al party controllers operate as peers on a number of sub-networks with the building co acting as a router to connect the high speed network and sub-networks.
- G. LAN: Local Area Network.
- H. MS/TP: Master slave/token passing.
- I. PC: Personal computer.

- J. PID: Proportional plus integral plus derivative.
- K. RTD: Resistance temperature detector.

## 1.3 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
  - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
  - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
  - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
  - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
  - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
  - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
  - 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
  - 8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
    - a. Water Temperature: Plus or minus 1 deg F.
    - b. Water Flow: Plus or minus 5 percent of full scale.
    - c. Water Pressure: Plus or minus 2 percent of full scale.
    - d. Space Temperature: Plus or minus 1 deg F.
    - e. Ducted Air Temperature: Plus or minus 1 deg F.
    - f. Outside Air Temperature: Plus or minus 2 deg F.
    - g. Dew Point Temperature: Plus or minus 3 deg F.
    - h. Temperature Differential: Plus or minus 0.25 deg F.
    - i. Relative Humidity: Plus or minus 5 percent.
    - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
    - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
    - 1. Airflow (Terminal): Plus or minus 10 percent of full scale.
    - m. Air Pressure (Space): Plus or minus 0.01-inch wg.
    - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
    - o. Carbon Monoxide: Plus or minus 5 percent of reading.
    - p. Carbon Dioxide: Plus or minus 50 ppm.
    - q. Electrical: Plus or minus 5 percent of reading.

### 1.4 SEQUENCE OF OPERATION

A. General

- 1. Provide fully implemented application and custom software, controllers, network id and controls devices necessary to accomplish the control sequence in conformance with the control diagrams.
- 2. Points to be alarmed and/or monitored shall be as described in the sequences r indicated on drawings.
- 3. All set points shall be adjustable.
- 4. In the event of a power failure all controls shall go to their fail open (FO), fail close or fail last (FL) positions as indicated on drawings.
- 5. The BMS shall have a sequential restart program for the restart of all equipment (fans, AHU's etc.) upon restoration of power after a loss of power.
- 6. Provide alarm monitoring of chilled water supply & return water temperatures, building hot water supply and return water temperatures, steam boiler pressure, and sump water temperature and level. All alarm monitoring shall be via separate BMS controller for diversity.

## 1.5 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
  - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufa and model number. Include technical data for interface equipment, control transducers/transmitters, sensors, actuators, valves, relays/switches, control panel operator interface equipment.
  - 2. Control System Software: Include technical data for operating system software, or interface, color graphics, and other third-party applications.
  - 3. Controlled Systems: Instrumentation list with element name, type of c manufacturer, model number, and product data. Include written description of seq of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
  - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  - 3. Wiring Diagrams: Power, signal, and control wiring.
  - 4. Details of control panel faces, including controls, instruments, and labeling.
  - 5. Schedule of dampers including size, leakage, and flow characteristics.
  - 6. Schedule of valves including flow characteristics.
  - 7. DDC System Hardware:
    - a. Wiring diagrams for control units with termination numbers.
    - b. Schematic diagrams and floor plans for field sensors and control hardware.
    - c. Schematic diagrams for control, communication, and power wiring, showing data conductors and wiring between operator workstation and contra locations.

- 8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
- 9. Controlled Systems:
  - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
  - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
  - c. Written description of sequence of operation including schematic diagram.
  - d. Points list including identification number, display units, set points, alert set points, point type (AO, Al, DO, DI), manufacturer and model number.
- C. Data Communications Protocol Certificates: Certify that each proposed DDC component complies with ASHRAE 135.
- D. Software and Firmware Operational Documentation: Include the following:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.
  - 5. Software license required by and installed for DDC workstations and control systems.
- E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- F. Field quality-control test reports as described in Part 3 of this specification.
- G. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
  - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
  - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
  - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
  - 5. Calibration records and list of set points.

### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. All work, materials and equipment shall comply with the rules and regulations of all cod, ordinances of the local, state and federal authorities. As a minimum the installation shall with the current editions of the following codes:

- 1. National Electrical Code (NEC)
- 2. Uniform Building Code (UBC)
- 3. Uniform Mechanical Code (UMC)
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with ASHRAE 135-2004 for DDC system components.

# 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

### 1.8 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- C. Coordinate equipment with Division 26 Section "Common Work Results for Electrical" to achieve compatibility of communication interfaces.
- D. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- E. Coordinate equipment with Division 26 Section "Common Work Results for Electrical" to achieve compatibility with motor starters and annunciation devices.

# 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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 CONTROL SYSTEM

- A. Manufacturers:
  - 1. System Manufacturer and Installer:
    - a. Existing system to be expanded/extended by Comfort Systems USA, of Louisville, Kentucky.
  - 2. Miscellaneous Devices:
    - a. Belimo Air Controls (USA), Inc.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multitasking environment on token-passing network and program control and monitor mechanical and electrical systems. Software and hardware for operator workstation that permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

## 2.3 DDC EQUIPMENT

- A. Operator Workstation: Contractor shall utilize existing operator's workstation.
- B. Communication
  - 1. Control products, communication media, connectors, repeaters, hubs, and routs comprise a network. Controllers and operator interfaces communication conform to ANSI/ASHRAE Standard 135-2004, BACnet communication protocol.
  - 2. Each controller shall have a communication port for connection to an operator internetwork.
  - 3. Controllers on the internetwork shall be provided with a 56,000 baud modem to allow for remote operator interface allowing communication with any and all control this network as described below.
  - 4. Internetwork operator interface and value passing shall be transparent to the internal architecture.
    - a. An operator interface connected to a controller shall allow the operator to interface with each network controller as if directly connected. Controller information such as data, status, reports, system software and customer programs shall be viewable and editable from each internetwork controller.
    - b. Inputs, outputs and control variables used to integrate control strategies multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified system operations. An authorized operator shall be able to edit cross-controller links by typing a standard object address.
  - 5. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices and wiring. Expansion shall not operator interface hardware addition or software revisions.

- C. Controller Software
  - 1. Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation.
  - 2. System Security
    - a. User access shall be secured using individual security passwords and user name.
    - b. Passwords shall restrict the user to the objects, applications and system as assigned by the system manager.
    - c. User log on/log off attempts shall be recorded.
    - d. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
  - 3. Scheduling. Provide the capability to schedule each object or group of object system. Each schedule shall consist of the following:
    - a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start stop and night economizer. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust and stop times for each member.
    - b. Exception Schedules. Provide the ability for the operator to designate any of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
    - c. Holiday Schedules. Provide the capability for the operator to define a special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
  - 4. System Coordination. Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.
  - 5. Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
  - 6. Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
  - 7. Alarm Reporting. The operator shall be able to determine the action to be taken in event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, print, be logged even log, generate custom messages and display graphics.
  - 8. Remote Communication. The system shall have the ability to dial out in the event of alarm.
  - 9. Demand Limiting.
    - a. The demand limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted building power meter or from a watt transducer or current transformer attached to the building feeder lines.

- b. The demand limiting program shall predict the probable power demand such that action can be taken to prevent exceeding the demand limit; action will be to reduce loads in a predetermined manner. When demand prediction indicates the demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
- c. Demand reduction shall be accomplished by the following means:
  - 1) Reset air handling unit supply temperature set point up by  $2^{\circ}$ F.
  - 2) Reset space temperature set points up by  $2^{\circ}$ F.
  - 3) De-energize equipment based upon priority.
- d. Demand limiting parameters, frequency of calculations, time intervals and relevant variables shall be based on the means by which the local power company computes demand changes.
- e. Provide demand limiting prediction and control for any individual meter by the system or for the total of any combination of meters.
- f. Provide the means for an operator to make the following changes online:
  - 1) Addition and deletion of loads controlled.
  - 2) Changes in demand intervals.
  - 3) Changes in demand limit for meter(s).
  - 4) Maximum shutoff time for equipment.
  - 5) Minimum shutoff time for equipment.
  - 6) Select rotational or sequential shedding and restoring.
  - 7) Shed/restore priority.
- g. Provide the following information and reports, to be available on an hour and monthly basis:
  - 1) Total electric consumption.
  - 2) Peak demand.
  - 3) Date and time of peak demand.
  - 4) Daily peak demand.
- 10. Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.
- 11. Sequencing. Provide application software based upon the sequence of operation specified to properly sequence chillers, boilers and pumps.
- 12. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time analog value that is used to position and output or stage a series of output controlled variable, set point, and PID gains shall be user-selectable.
- 13. Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order, in which equipment, or groups of equipment) is started, along with the time delay between starts, shall be user selectable.
- 14. Energy Calculations.
  - a. Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., gpm) to be accumulated and converted to energy usage data.

- b. Provide and algorithm that calculates a sliding window average (e.g., average). The algorithm shall be flexible to allow window intervals to be specified (e.g., 15 minutes, 30 minutes, 60 minutes).
- c. Provide and algorithm that calculates a fixed window average. A digit signal will define the start of the window period (e.g., signal from utility meter) to synchronize the fixed window average with that used by the utility.
- 15. Anti-Short Cycling. All binary output objects shall be protected from short cycling feature shall allow minimum on-time and off-time to be selected.
- 16. On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and set point. The algorithm shall be direct or reverse-acting and incorporate an adjustable differential.
- 17. Run Time Totalization. Provide software to totalize run times for all binary input. A high run time alarm shall be assigned, if required, by the operator.
- D. Building Controllers
  - 1. General. Provide the minimum number of building controllers as indicated drawings to achieve the performance specified in the Part 1 Article on "System Performance". Each of these panels shall meet the following requirements:
    - a. The Building Management System shall be composed of one or more independent, stand alone, microprocessor-based building controllers to manage the global strategies described in the system software section.
    - b. The building controller shall have sufficient memory to support its operating system, database and programming requirements.
    - c. Data shall be shared between networked building controllers.
    - d. The operating system of the building controller shall manage the input and communication signals to allow distributed controllers to share real and object information and allow for central monitoring and alarms.
    - e. Controllers that perform scheduling shall have a real time clock.
    - f. The building controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
      - 1) Assume a predetermined failure mode.
      - 2) Generate an alarm notification.
  - 2. Communication
    - a. The building controller shall communicate with other building controller operator workstations through a high speed network utilizing BACnet II custom application controllers, application specific controllers and third equipment controllers through a sub-network utilizing BACnet MS/TP.
    - b. The building controller shall provide a service communication for connection to a portable operator's terminal.
  - 3. Environment. Controller hardware shall be suitable for the anticipated ambient condition.
    - a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at  $-40^{\circ}$ F to  $40^{\circ}$ C.

- b. Controllers used in conditioned space shall be mounted in dust-proof enclosure and shall be rated for operation at 32°F to 120°F (0°C to 50°C).
- 4. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system password shall be available to prevent unauthorized use of the keypad and display manufacturer does not provide this keypad and display, provide a second portable operator terminal.
- 5. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips termination card connected by a ribbon cable.
- 6. Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- 7. Immunity to power and noise. Controller shall be able to operate at 90% to 110% nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and keyed radios up to 5W at 3 ft (1m).
- E. Custom Application Controllers
  - 1. General. Provide an adequate number of Custom Application Controllers (CAC) achieve the performance specified in the Part 1 Article on "System Performance". Each of these panels shall meet the following requirements
    - a. The custom application controller shall have sufficient memory to support its operating system, database and programming requirements.
    - b. Data shall be shared between networked custom application controllers.
    - c. The operating system of the controller shall manage the input and communication signals to allow distributed controllers to share real and object information and allow central monitoring and alarms.
    - d. Controllers that perform scheduling shall have a real time clock.
    - e. The custom application controller shall continually check the status of its pro and memory circuits. If an abnormal operation is detected, the controller shall:
      - 1) Assume a predetermined failure mode.
      - 2) Generate an alarm notification
  - 2. Communication
    - a. The custom application controller shall communicate with other custom application controllers, application specific controllers and third party controllers through bus utilizing BACnet MSITP.
    - b. The custom application controller shall provide a service communication for connection to a portable operator's terminal.
  - 3. Environment. Controller hardware shall be suitable for the anticipated conditions.
    - a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°C to 65°C).
    - b. Controllers used in conditioned space shall be mounted in dust-proof an and shall be rated for operation at  $32^{\circ}$ F to  $120^{\circ}$ F ( $0^{\circ}$ C to  $50^{\circ}$ C).

- 4. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display manufacturer does not provide this keypad and display, provide a second portable operator terminal.
- 5. Serviceability. Provide diagnostic LEDs for power, communication, and process wiring connections shall be made to field-removable, modular terminal strips termination card connected by a ribbon cable.
- 6. Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
- 7. Immunity to power and noise. Controller shall be able to operate at 90% to 110% nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and keyed radios up to 5W at 3 ft (1 m).
- F. Application Specific Controllers
  - 1. General. Application specific controllers (ASCs) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user-programmable but are customized for operation within the confines of the equipment they are designated to serve.
    - a. Each ASC shall be capable of stand alone operation and shall continue to provide control functions without being connected to the network.
    - b. Each ASC will contain sufficient I/O capacity to control the target system.
  - 2. Communication
    - a. The application specific controller shall communicate with other custom application controllers, application specific controllers and third party controllers through bus utilizing BACnet MS/TP.
    - b. The application specific controller shall provide a service communication for connection to a portable operator's terminal.
  - 3. Environment. The hardware shall be suitable for the anticipated ambient condition.
    - a. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°F to 150°F.
    - b. Controllers used in conditioned space shall be mounted in dust-proof enclosure and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
  - 4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  - 5. Memory. The application specific controller shall use nonvolatile memory and all BIOS and programming information in the event of a power loss.
  - 6. Immunity to power and noise. Controller shall be able to operate at 90% to 110% nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz from keyed radios up to 5 W at 3 ft.

- 7. Transformer. Power supply for the ASC must be rated at a minimum of 125% power consumption and shall be of the fused or current limiting type.
- G. Input/Output Interface
  - 1. Hardwired inputs and outputs may tie into the system through building, application, or application specific controllers.
  - 2. All input points and output points shall be protected such that shorting of the point itself, to another point, or to ground will cause no damage to the controller. All output points shall be protected from voltage up to 24V of any duration, such that with this voltage will cause no damage to the controller.
  - 3. Binary inputs shall allow the monitoring of On/Off signals from remote device; binary inputs shall provide a wetting current of at least 12mA to be compatible commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
  - 4. Pulse accumulation input objects. This type of object shall conform to requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.
  - 5. Analog inputs shall allow the monitoring of low voltage (0 to 10 VDC), current (4-20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
  - 6. Binary outputs shall provide On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application control shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.
  - 7. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (Auto/Manual) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
  - 8. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for threepoint floating type electronic actuators without feedback. Use of three-point devices shall be limited to zone control and terminal unit control application terminal units, duct mounted heating coils, zone dampers, radiation, etc). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
  - 9. Input/Output points shall be the universal type, i.e., controller input or output may be designated (in software) as either binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.
  - 10. System Object Capacity. The system size shall be expandable to at least (20) times the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require hardware additions or software revisions in order to expand the system.
- H. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protect ion; limit connected loads to 80 percent of rated capacity. DC power supply shall match output and voltage requirements and be full-wave rectifier type with the following:
  - 1. Output ripple of 5.0 mV maximum peak to peak.

- 2. Combined 1 percent line and load regulation with 100-mic.sec. response time percent load changes.
- 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 overload for at least 3 seconds without failure.
- I. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
  - 1. Minimum dielectric strength of 1000 V.
  - 2. Maximum response time of 10 nanoseconds.
  - 3. Minimum transverse-mode noise attenuation of 65 dB.
  - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

### 2.4 PANELS

- A. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
- B. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- C. Provide ON/OFF power switch with overcurrent protection for control power sources local panel.

# 2.5 ELECTRONIC SENSORS AND TRANSMITTERS

- A. Manufacturers:
  - 1. Room Temperature Sensors (TT)
    - a. Automation Components, Inc. (ACI)
    - b. Honeywell, Inc.
    - c. Johnson Controls, Inc.
    - d. Siemens Controls, Inc.
  - 2. Temperature Elements/Transmitters (TT)
    - a. Automation Components, Inc. (ACI)
    - b. Honeywell, Inc.
    - c. HyCal Sensing Products.
    - d. Johnson Controls, Inc.
    - e. Rosemount.
    - f. Siemens Controls, Inc.
    - g. Vaisala, Inc.
    - h. Yokogawa.

- 3. Humidity (Moisture) Transmitters (HT)
  - a. Automation Components, Inc. (ACI)
  - b. General Eastern Instruments, Inc.
  - c. HyCal Sensing Products.
  - d. Johnson Controls, Inc.
  - e. Siemens Controls, Inc.
  - f. Vaisala, Inc.
- 4. Temperature/Moisture Transmitters (TT/HT)
  - a. General Eastern Instruments, Inc.
  - b. HyCal Sensing Products.
  - c. Vaisala, Inc.
- 5. Dew Point Temperature/Moisture Transmitters (TT/HT)
  - a. General Eastern Instruments, Inc.
  - b. HyCal Sensing Products.
  - c. Vaisala, Inc.
- 6. Flow (FT), Pressure (PT) and Pressure Differential (PDT) Transmitters
  - a. Air Monitor Corporation.
  - b. Ashcroft.
  - c. Dwyer Instruments, Inc.
  - d. Foxboro.
  - e. Honeywell, Inc.
  - f. Rosemount.
  - g. Setra Systems, Inc.
  - h. Yokogawa.
- 7. Pressure Differential Indicating Switches (PDIS)
  - a. Dwyer Instruments, Inc.
- B. All sensors/transmitters being controlled or monitored by CFR compliant system shall be traceable and provided with certification documents.
- C. Description: Vibration and corrosion resistant; for wall, immersion, or duct mount required.
- D. Thermistor Room Temperature Sensors (TT) for non-manufacturing and laboratory areas
  - 1. Accuracy: Plus or minus 0.36 deg F (0.2 deg C) at calibration point.
  - 2. Wire: Twisted, shielded-pair cable.
  - 3. Resistance: 10,000 Ohms.
  - 4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    - a. Set-Point Adjustment: Concealed.
    - b. Set-Point Indication: Concealed.
    - c. Digital temperature display.

- 5. Room Security Sensors: Stainless-steel cover plate with insulated back and screws.
- 6. Basis of design product: Subject to compliance with requirements, provide Siemens Series 1000 Room Temperature Sensor or comparable product from manufacture above.
- E. RTDs and Transmitters (Air and Water, TT):
  - 1. Accuracy: Plus or minus 1.0% of calibrated span.
  - 2. Temperature Element: 100 Ohm or 1000 Ohm Platinum Class A RTD.
  - 3. Wire: Twisted, shielded-pair cable.
  - 4. Output Signal: 4 to 20 mA, linear.
  - 5. Temperature Range: Room/Duct 40°F to 110°F, Outdoor Air -20°F to 140°F, Water to 220°F or as noted on drawings.
  - 6. NIST traceable.
  - 7. Insertion Elements in Ducts: Single point, minimum 8 inches (200 mm) long; use not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
  - 8. Averaging Elements in Ducts: Minimum of 60 inches/10 square feet of duct free area; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
  - 9. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
  - 10. Room Transmitter Cover Construction: Manufacturer's standard locking covers.
    - a. Set-Point Adjustment Concealed.
    - b. Set-Point Indication: Concealed.
    - c. LCD temperature display.
  - 11. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
  - 12. Room Security Sensors: Stainless-steel cover plate with insulated back and screws.
  - 13. Basis of design product: Subject to compliance with requirements, provide ACI A/TT 100 or comparable product from manufacturers listed above.
- F. Moisture/Humidity Transmitter (HT).
  - 1. Accuracy: 2 percent full range.
  - 2. Range: 0 to 100 percent relative humidity.
  - 3. Drift: Shall not exceed 1% of full scale per year.
  - 4. Output Signal: 4 to 20 mA, linear.
  - 5. MIST traceable.
  - 6. Room Sensor Cover Construction: Manufacturers standard locking covers.
  - 7. Outside-Air Sensor: Suitable for operation at outdoor temperatures of minus 22 to 185 deg F with mounting enclosure.
  - 8. Duct Sensors: Suitable for operations at temperatures of 30°F to 140°F with guard and mounting plate
  - 9. Basis of design product: Subject to compliance with requirements, provide HMDNV60 or comparable product from manufacturers listed above.
- G. Temperature
  - 1. Accuracy: 2 percent full range (RH) and t 1.0% of calibrated span (temperature).
  - 2. Range: 0 to 100 percent relative humidity, -4°F to 176°F dry bulb temperature.
  - 3. Drift: Shall not exceed 1% of full scale per year.

- 4. Output Signals (2): 4 to 20 mA, linear for dry bulb temperature and relative humidity.
- 5. NIST traceable.
- 6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
- 7. Outside-Air Sensor: Suitable for operation at outdoor temperatures of minus 22 to 185 deg F with mounting enclosure.
- 8. Duct Sensors: Suitable for operations at temperatures of 30°F to 140°F with guard and mounting plate
- 9. Basis of design product: Subject to compliance with requirements, provide HMD/W60 or comparable product from manufacturers listed above.
- H. Dew Point Temperature /Moisture Transmitter (TT/HT)
  - 1. Accuracy: 2 percent full range (I  $\pm$  1.0% of calibrated span (temperature).
  - 2. Range: 0 to 100 percent relative humidity, -4°F to 176°F dew point temperature and 40°F to 176°F dry bulb temperature.
  - 3. Drift: Shall not exceed 1% of full scale per year.
  - 4. Output Signals (2): 4 to 20 mA, linear for dry bulb temperature and dew point temperature/relative humidity.
  - 5. Display: LED of both dry bulb and dew point temperatures.
  - 6. NIST traceable.
  - 7. Outside-Air Sensor: Suitable for operation at outdoor temperatures of minus 22 to 185 deg F with mounting enclosure.
  - 8. Duct Sensors: Suitable for operations at temperatures of 30°F to 140°F with guard and mounting plate
  - 9. Basis of design product: Subject to compliance with requirements, provide Vaisala 100 or comparable product from manufacturers listed above.
- I. Flow (FT), Pressure (PT) and Pressure Differential (PDT) Transmitters:
  - 1. Air Flow (FT) and Pressure Differential (PDT) Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
    - a. Accuracy:  $\pm 1.0\%$  FS including effects of linearity, hysteresis and repeatability.
    - b. Output: 4 to 20 mA for linear or square root.
    - c. Pressure Differential Range: As noted on drawings or as required for flow for FT.
    - d. Overpressure Limit: 10-psig.
    - e. NIST traceable.
    - f. Basis of design product: Subject to compliance with requirements, provide Model 264 or comparable product from manufacturers listed above.
  - 2. Air Pressure Differential Indicating Transmitter (PDIT): Non-directional sensor with suitable range for expected input, and temperature compensated.
    - a. Accuracy:  $\pm 1.0\%$  FS including effects of linearity, hysteresis and repeatability.
    - b. Output: 4 to 20 mA for linear or square root.
    - c. Display: LCD.
    - d. Pressure Differential Range: As noted on drawings or as required for flow for FT.
    - e. Overpressure Limit: 10-psig.
    - f. NIST traceable.
    - g. Basis of design product: Subject to compliance with requirements, provide Model 267 or comparable product from manufacturers listed above.

- 3. Air Pressure Sensors (PE): Shielded static pressure probes shall be provided for room pressure differential and duct static pressure monitoring.
  - a. Probe shall have multiply sensing ports, pressure impulse suppression chamber air flow shielding and takeoff fitting contained in an aluminum casing or stainless steel if noted on drawings, with brushed finish on exposed surfaces.
  - b. Room sensor shall sense static pressure in the proximity of the sensor with the actual pressure value while being subjected to a maximum airflow 1000 FPM from a 360° radial source.
  - c. Probe shall be self-draining where room washdown is required.
  - d. Basis of design product: Subject to compliance with requirements, provide air Monitor corporation S.A.P. or comparable product from manufacturer above.
- 4. Water Flow Transmitter (FT), Pressure (PT) and Pressure Differential Transmitters: All stainless-steel wetted parts, suitable for service indicated, LED of pressure and status switch.
  - a. Accuracy: ±0.15% of span including effects of linearity, hysteresis repeatability.
  - b. Rangeability: 100 to 1
  - c. Output: 4 to 20 mA for linear or square root.
  - d. Pressure range: As noted on drawings or as required for flow element for F
  - e. Minimum 150-psig operating pressure and tested to 300-psig.
  - f. Manifold: Integral manifold with "flangeless valves". Block and bleed for DI five valve for FT and PDT.
  - g. NIST traceable.
  - h. Basis of design product: Subject to compliance with requirements, Rosemount 3051CD (FT & PDT), Rosemount 3051T (PT) or comparable from manufacturers listed above.
- 5. Air Pressure Differential Indicting Switch (PDIS): Pressure indicating gage phototransistor circuits and two DPDT relay for high and low limit indication.
  - a. Accuracy:  $\pm 2.0\%$  FS.
  - b. Set Point Adjustment: High and low set points adjustable from front of gage.
  - c. Outputs: Each set point has two Form C relays (DPDT).
  - d. Pressure Differential Range: As noted on drawings.
  - e. Pressure Limits: -20" Hg to 25 psig.
  - f. NIST traceable.
  - g. Basis of design product: Subject to compliance with requirements, provide Series A 3000 or comparable product from manufacturers listed above.

### 2.6 STATUS SENSORS

- A. Status Inputs for Fans (PDS): Differential-pressure switch with pilot-duty rating and with adjustable range suitable for maximum dead head pressure of fan.
- B. Status Inputs for Pumps (PDS): Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range suitable for maximum dead head pressure of pump, across pump.

- C. Current Switches (IS): AC current switch shall be the self-powered, combination split-core current transformer type with either normally open (NO) or normally closed (NC) solid state output, adjustable trip set point and green/red LED to monitor status of switch. Units shall be suitable to continuously monitor currents up to 250 Amps. Comply with ISA 50.00.0 suitable for 175 percent of rated motor current.
- D. Current Transmitter (IT): AC current transmitters shall be the self-powered, combination splitcore current transformer type with built-in rectifier and high-gain servo amplifier with 4 to twowire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale internal zero and span adjustment and  $\pm 1\%$  full-scale accuracy at 500 ohm maximum burden. Comply with ISA 50.00.01 and suitable for 175 percent of rated motor current.
- E. Electronic Valve/Damper Position Indicator (ZI): Visual scale indicating percent of travel to 10-V dc, feedback signal.
- F. Valve/Damper Position Switch (ZS); Mechanically activated electrical switch (SPDT) providing accurate and reliable indication that valve/damper is fully open or fully closed.
- G. Water-Flow Switches (FS): Bellows-actuated mercury or snap-acting type with pilot-duty stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
- H. Pressure-Electric Switches (XS<sup>P</sup>): Shall be metal or neoprene diaphragm actuated, pressure rated 0-175 kPa (0-25 psig), with calibrated scale setpoint range of 14-125 kPa minimum. UL listed. Provide one- or two-stage switch action SPDT, DPST, or DP required by application. Electrically rated for pilot duty service (125 VA minimum) motor control. Shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified and have a permanent indicating gauge on each pneumatic signal line to PE switches.

### 2.7 GAS DETECTION EQUIPMENT

- A. Manufacturers:
  - 1. H2scan.
  - 2. INTEC Controls, Inc.
  - 3. MSA Canada Inc.
  - 4. QEL/Quatrosense Environmental Limited.
  - 5. Sensidyne, Inc.
- B. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrate to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- C. Hydrogen Sensor and Transmitter: Suitable over a temperature range of minus 60 to deg F (-20 to 40 deg C) and calibrated for 0.4 to 5.0 percent hydrogen by volume and 1- percent lower flammability limit, 4- to 20-mA output and two programmable 60 VDC/1A SPDT relays with both normally open and normally closed contacts; for wall or ceiling mounting.

### 2.8 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
  - 1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 2. 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.
  - 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
  - 4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
  - 5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
  - 6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
  - 1. Manufacturers:
    - a. Belimo Aircontrols (USA), Inc.
  - 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
  - 3. Dampers: Size for running torque calculated as follows:
    - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. damper.
    - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. damper.
    - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft damper.
    - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. damper.
    - e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
    - f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.
  - 4. Coupling: V-bolt and V-shaped, toothed cradle.
  - 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  - 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
  - 7. Power Requirements (Two-Position Spring Return): 24 or 120-V ac as determined by BMS provider.
  - 8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
  - 9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  - 10. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).

- 11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
- 12. Run Time: 12 seconds open, 5 seconds closed.

### 2.9 CONTROL VALVES

- A. Manufacturers:
  - 1. Asco.
  - 2. Baumann Valves.
  - 3. Fisher Controls, Inc.
  - 4. Johnson Controls, Inc.
  - 5. Magnatrol Valve Corporation.
  - 6. Siemens Controls, Inc.
  - 7. Spence Engineering Co., Inc.
  - 8. Warren Controls.
- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Hydronic system globe valves shall have the following characteristics:
  - 1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity re-packable under pressure.
  - 2. NPS 2-1/2 (ON 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug type disc, flanged ends, and renewable seat and disc.
  - 3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
    - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
  - 4. Sizing: Maximum pressure drop at design flow rate shall be as indicated in Contra Schedule on drawings, otherwise as follows:
    - a. Two Position: Line size.
    - b. Two-Way Modulating: Five (5) psig or twice the pressure drop through the heat exchanger, whichever is more.
    - c. Three-Way Modulating: Five (5) psig or the pressure drop through the coil exchanger, whichever is more.
  - 5. Flow Characteristics: Two-way valves shall have equal percentage characteristic way valves shall have linear characteristics. Rangeability shall be 50 to 1.
  - 6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall minimum close-off pressure rating of 150 percent of total system (pump) head way valves and 100 percent of pressure differential across valve or 100 percent system (pump) head.

- D. Steam system globe valves shall have the following characteristics:
  - 1. NPS 2 (ON 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity re-packable under pressure.
  - 2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug type disc, flanged ends, and renewable seat and disc.
  - 3. Internal Construction: Replaceable plugs and stainless-steel seats.
    - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
    - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
  - 4. Sizing: For pressure drop based on the following services:
    - a. Two Position: Less than 10 percent of inlet pressure.
    - b. Modulating 15-psig (103-kPa) Steam: 80 percent of inlet steam pressure.
    - c. Modulating 16- to 50-psig (110- to 350-kPa) Steam]: 50 percent of inlet pressure.
    - d. Modulating More Than 50-psig (350-kPa) Steam: As indicated.
  - 5. Flow Characteristics: Modified linear characteristics with rangeability of 30 to 1.
  - 6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall minimum close-off pressure rating of 150 percent of operating (inlet) pressure.
- E. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
  - 1. Body Style: Lug.
  - 2. Disc Type: Elastomer-coated ductile iron.
  - 3. Sizing: Pressure drop as scheduled or indicated above at design flow rate.
- F. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
  - 1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
  - 2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
  - 3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; threeway valves shall have linear characteristics.
- G. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
  - 1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
  - 2. Thermostatic Operator. Liquid-filled, integral or remote sensor with integral adjustable dial.

### 2.10 DAMPERS

A. All dampers shall be provided by mechanical contractor or air handling unit manufacturer. BMS provider shall coordinate with mechanical contractor and air handling unit manufacturer on installation by BMS provider of actuators and other control devices.

### 2.11 WIRING AND RACEWAYS

- A. General: Provide copper wiring, plenum cable, and raceways as specified in the appropriate sections of Division 26.
- B. All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

## 2.12 FIBER OPTIC CABLE SYSTEM

- A. Optical cable: Optical cables shall be duplex 900 in tight-buffer construction designed fior intrabuilding environments. The sheath shall be UL listed OFNP in accordance with NEC 770. The optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/1.
- B. Connectors: All optical fibers shall be field-terminated with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

### PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment location. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. The contractor shall examine the drawings and specifications for other parts of the head room or space conditions appear inadequate or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any change: work covered by this specification made necessary by the failure or neglect of the contractor's report such discrepancies shall be made by and at the expense of this contractor.
- D. The contractor shall verify that power supply is available to control units and workstation.
- E. The contractor shall verify that duct-, pipe-, and equipment-mounted devices are before proceeding with installation.

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### 3.2 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 60 inches (1220 mm) above the floor.
  - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats in the following locations:
  - 1. Entrances.
  - 2. Public areas.
  - 3. Where indicated.
- E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- I. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."
- J. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- K. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- L. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

### 3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Temperature Controls Contractor shall be responsible for all electricals to their equipment/components.
- B. Install raceways, boxes, and cabinets according to Division 26 Section "Common Work Results for Electrical."
- C. Install building wire and cable according to Division 26 Section "Common Work Results for Electrical."

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- D. Install signal and communication cable according to Division 27 Section "Structured Cabling."
  - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  - 2. Install exposed cable in raceway.
  - 3. Install concealed cable in raceway.
  - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side, protect against abrasion. Tie and support conductors.
  - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

## 3.4 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system. Points used for control loop reset, such as outside air or space temperature, are exempt form this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.
  - 1. Future use of spare capacity shall required providing the field device, field wiring, point data-base definition, and custom software. No additional controller boards or modules shall be required to implement use of these spare points.

## 3.5 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% available memory free for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator in without the use of a written point index. Use naming convention indicated on control and in sequences.
- C. Software Programming
  - 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Imbed control program sufficient comment statements to clearly describe each section program. The

comment statements shall reflect the language used in the sequel operation. Use the appropriate technique based on the following programming types:

- a. Text based:
  - 1) Must provide actions for all possible situations.
  - 2) Must be modular and structured.
  - 3) Must be commented.
- b. Graphic based:
  - 1) Must provide actions for all possible situations.
  - 2) Must be documented.
- c. Parameter based:
  - 1) Must provide actions for all possible situations.
  - 2) Must be documented.

### D. Operator Interface

- 1. Standard graphics Provide graphics for all mechanical systems and floor plan building. This includes each chilled water system, hot water system, chiller, air handler, and all terminal equipment. Point information on the graphic displays dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
- 2. Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.
- 3. The contractor shall provide all the labor necessary to install, initialize, start of troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, third-party software installation and integration required for successful operation operator interface.

#### 3.6 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started from the DDC system.
  - 1. Labels shall use white lettering (12-point type or larger) on a red background.
  - 2. Warning labels shall read as follows: "CAUTION This equipment is operating automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing."
- B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
  - 1. Labels shall use white lettering (12-point type or larger) on a red background.
  - 2. Warning labels shall read as follows: "CAUTION This equipment is fed form more than one power source with separate disconnects. Disconnect all power sources before servicing."

### 3.7 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled end within 2 in of termination with the DDC address or termination number.
- B. Permanently label or code each point of field terminal strips to show the instrument served.
- C. Identify control panels with minimum 1 cm (1/2 in.) letters on laminated plastic nameplate.
- D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- E. Identify room sensors relating to terminal box or valves with nameplates.
- F. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- G. Identifiers shall match record documents.

### 3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  - 2. Test and adjust controls and safeties.
  - 3. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  - 4. Test each system for compliance with sequence of operation.
  - 5. Test software and hardware interlocks.
- C. DDC Verification:
  - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
  - 2. Check instruments for proper location and accessibility.
  - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
  - 4. Check instrument tubing for proper fittings, slope, material, and support.
  - 5. Check installation of air supply for each instrument.
  - 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
  - 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
  - 8. Check temperature instruments and material and length of sensing elements.
  - 9. Check control valves. Verify that they are in correct direction.
- 10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
- 11. Check DDC system as follows:
  - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
  - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
  - c. Verify that spare I/O capacity has been provided.
  - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

# 3.9 ADJUSTING

- A. Calibrating and Adjusting:
  - 1. Test equipment shall be NIST traceable.
  - 2. Calibrate instruments.
  - 3. Make three-point calibration test for both linearity and accuracy for each analog instrument.
  - 4. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
  - 5. Control System Inputs and Outputs:
    - a. Check analog inputs at 0, 50, and 100 percent of span.
    - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    - c. Check digital inputs using jumper wire.
    - d. Check digital outputs using ohmmeter to test for contact making or breaking.
    - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
  - 6. Flow:
    - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    - b. Manually operate flow switches to verify that they make or break contact.
  - 7. Pressure:
    - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
  - 8. Temperature:
    - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    - b. Calibrate temperature switches to make or break contacts.

- 9. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
- 10. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
- 11. Provide diagnostic and test instruments for calibration and adjustment of system.
- 12. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

# 3.10 SITE ACCEPTANCE TEST

- A. General:
  - 1. This test shall demonstrate that the work specified in this specification is in accordance with the Contract Documents without fault or defect of any kind.
  - 2. Upon completion of the work covered by this specification, and after systems are set and adjusted, conduct performance tests of various systems and devices shall be carried out under supervision of Owner or Owner's Representative acceptance of control system shall be arranged for purpose of demonstrating satisfactory functional and accurate operating characteristics as well as adjustment.
  - 3. During this period, setting of instrumentation and equipment shall be check and sufficient measurements taken to ensure that conditions are correct, and capacities are adequate to meet specified requirements. Provide competent personnel to conduct System will not be considered complete until tests have been concluded to satisfaction of Owner and other parties having jurisdiction. In event of faults or defects, tests must be repeated after faults and defects are corrected. Tests shall be performed in presence of the Owner or Owner's Representative. Tests shall be performed under as near conditions as possible.
  - 4. Furnish instruments, test equipment and personnel required for tests. Owner will provide electrical power and water for tests.
  - 5. Control system shall be tested in 'step by step' manner following approved procedures. Tests shall include but not necessarily be limited to the following:
    - a. Control system shall be exercised to demonstrate that requirements of monitor and control have been met and that control system has been adjusted and will operate as specified.
    - b. Contractor shall demonstrate that points can be interrogated and commanded as specified.
    - c. Contractor shall demonstrate that control system software programs respective building, custom application and application specific controllers and function as specified.
  - 6. High speed network and sub-networks verification shall be performed with existing OWS and application programs operating under normal control system loading conditions.

- 7. Testing shall be conducted on control system exclusive of other usage. Simultaneous use of control system for development, debug, or other purpose shall not be during testing.
- 8. Precautions must be taken to ensure that no equipment shall be damaged during testing.
- 9. Records of tests including nameplate data for identification shall be retained for three copies in operating instructions. Records shall be on permanent record mat fit 8-1/2" x 11" binders.
- 10. Testing specified represents minimum requirements. Specific tests shall be required by applicable codes and jurisdictional authorities.
- 11. After completion of Acceptance Test, tests found to be unacceptable shall be recorded on field report that will be given promptly to contractor.
- 12. Field report items then found to be unacceptable shall require contractor to take further action to make them acceptable.
- 13. Reasonable time will be allowed for contractor to refine, replace, restore, repair or otherwise correct unacceptable work; however, contractor shall expedite such when field report items are corrected, the contractor shall request another test in writing.
- 14. Should additional expense occur to the Owner, due to repeated testing, such expense shall be deductible by Owner from final payment due contractor, not as a permit because contractor's failure to correct the work properly has made additional testing necessary. In the event of such deducted amount, Owner will furnish evidence expenses to contractor.
- 15. Responsibility for delays caused by equipment damaged or otherwise unavailable testing rests with contractor.
- 16. Satisfactory completion of Site Acceptance Test shall be requirement for final control system acceptance.
- 17. Contractor shall notify Owner and the Testing and Balancing Contractor when testing has been successfully completed.
- B. Operators Work Station (Existing)
  - 1. Contractor shall demonstrate capability of control system to perform data collection presentation, operator interface, supervisory control, communications and other functions specified.
  - 2. Contractor shall demonstrate that (existing) OWS configuration meets specified requirements for CPU, memory, disk storage, and expansion.
  - 3. Contractor shall demonstrate operation of (existing) OWS terminals.
  - 4. BAS contractor shall demonstrate that (existing) OWS software and database work specified is complete. (Existing) OWS software and database shall be installed a line throughout Acceptance Test.
  - 5. Contractor shall demonstrate that (existing) OWS software configuration work spec is complete. This shall include:
    - a. Database.
    - b. Graphics.
    - c. Reports.
    - d. Point groups.
    - e. Trends.
    - f. Alarms.
    - g. Historian.
    - h. Menu.
  - 6. Contractor shall maintain (existing) OWS password access security.

- 7. Contractor shall demonstrate that (existing) OWS meets specified requirements. The intent is also to demonstrate capabilities of (existing) OWS as in manufacturer's published product literature. Testing shall include but not ne be limited to:
  - a. Communications with building, custom application and application controllers.
    - 1) Report alarm and return to normal conditions.
    - 2) Report digital change of state.
    - 3) Report analog change of value.
    - 4) Downloading of data such as new setpoints.
    - 5) Report loss of building, custom application and application controllers communications.
  - b. Supervisory control functions.
  - c. Alarm display and acknowledgment.
  - d. Create new color graphic display
    - 1) Use of symbol library.
    - 2) Display change of value/status for analog/digital point.
    - 3) Flashing when point goes into alarm.
  - e. Create new report.
  - f. Monitor DDC control loop.
  - g. Trending.
    - 1) Create new trend group.
    - 2) Trend multiple analog points on the same display in real-time.
    - 3) Trend historical data.
  - h. Log on and log off procedures.
  - i. User interface including:
    - 1) Response to keyboard input errors.
    - 2) Function keys.
    - 3) Mouse (if applicable).
    - 4) Trackball (if applicable).
  - j. Operation of (existing) OWS local area network.
- C. Building, Custom Application and Application Specific Controllers
  - 1. Contractor shall demonstrate capability of control system to accurately monitor control field sensors and actuators specified. Tests shall be conducted to verify end accuracy and repeatability of control system in response to field inputs to custom application and application specific controllers, including accurate display of status and values and annunciation of alarms. Tests shall also be conducted to verify that control system accurately responds to commands to generate output specified. Monitoring and control functions specified shall be tested.
  - 2. Contractor shall demonstrate that each type of distributed processing units (building, custom application and application specific controllers) meets specified requirements for monitoring, control, interface to field sensors and actuators, software, communications

networked operation, and stand-alone operation. Intent is also to demonstrate capabilities of building, custom application and application specific controllers as stated in manufacturer's published literature. Testing of building, custom application and application specific controllers shall include but not necessarily be limited to:

- a. Communications with OWS.
  - 1) Report alarm and return to normal conditions.
  - 2) Report digital change of state.
  - 3) Report analog change of value.
  - 4) Execution of supervisory control commands.
  - 5) Downloading of data such as new setpoints.
- b. Controller to controller communications.
  - 1) Data from sensor connected to one building, custom application or application specific controller is available at another building, application or application specific controller on network.
  - 2) Alarm from sensor connected to one building, custom application or application specific controller initiates program or sequence in another building, custom application or application specific controller.
  - 3) Communications on each type of building, custom application or application specific controllers network and sub-network.
- c. Building, custom application and application specific controllers programming local terminal.
  - 1) Change setpoint.
  - 2) Change alarm limit.
- d. Automatic restart of building, custom application and application controllers after power failure.
- e. Battery backup of building, custom application and application specific controllers memory.
- f. Trending and data logging.
- g. Add new point using alphanumeric descriptive point name and demonstrate point is operational in the control system.
- h. Automatic scaling of analog data.
- i. Real-time clock and time schedule functions.
- j. Stand-alone control without communication with Host computer or other building custom application and application specific controllers.
- k. Manual override of automatic control functions.
- 3. Contractor shall demonstrate that control loops have been properly tuned and are performing control functions as specified in this section and as described on the Instrument & Control Diagram drawings. For each control loop, contractor must demonstrate the following, as a minimum:
  - a. Control system can maintain control loop setpoint within specified tolerance continuous period of no less than 30 minutes. Demonstration shall include minimum, hard copy listing control loop associated point values trended at

maximum 30 (thirty) second intervals. All software tuning parameters, time and filters utilized to meet this demonstration shall be submitted to Owner as a hardcopy of the tuning parameters baseline.

b. When offset to setpoint is introduced, control system can achieve control setpoint within five minutes after change has been made. Demonstration shall include, as a minimum, hard copy listing control loop associated point trended at maximum 15 (fifteen) second intervals. All software tuning parameters, time delays and filters utilized to meet this demonstration shall be submitted to Owner as a hardcopy of the tuning parameters baseline.

# 3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION 230900

# SECTION 230993 – SEQUENCES OF OPERATION

PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes sequence of operation for mechanical systems and equipment.
  - 1. Strictly adhere to specified sequences for respective equipment and systems.
  - 2. Furnish all devices required to accomplish respective operating sequences, whether specified or not.
  - 3. Devices not furnished by respective equipment manufacturer shall be supplied by TCC.
- B. Control Devices: Electric.

# PART 2 - PRODUCTS (NOT USED)

# PART 3 - EXECUTION (CONTROLS SEQUENCES)

# 3.1 FAN COIL UNITS

- A. Provide for automatic control of all 4-pipe Hydronic fan coil units.
- B. Provide digital interface between fan coil valve/fan controllers and the Building Energy Management System. Fan coil control with building automation system interface shall provide remote control and sensing of fan and valve operation and inlet/discharge water/air temperatures. Provide for alarm annunciation for fan failure or high/low discharge air temperatures.
- C. Fans shall operate continuously during Occupied and cycle to offset zone heat gains/losses in Unoccupied periods. Temperature setpoints and time schedules shall be adjustable.
- D. Hydronic valves shall modulate to offset space heat gains/losses.
- E. Chilled and hot water valves shall be electric operated, 2-position, modulating type.
- F. Motor operated O.A. damper shall modulate to automatically offset space CO2 levels. Maintain levels below 700 ppm. Each fan coil to operate independent.

#### 3.2 VARIABLE SPEED DRIVE CHILLERS

A. New chiller shall be operated in same manner as existing chiller.

### 3.3 RESTROOM EXHAUST FANS (EF-1)

A. Fans shall automatically start with activation of space occupancy sensor, provide a minimum 15-minute run, and automatically shut-off with no additional room traffic.

#### 3.4 VAV BOXES

- A. Provide BACNET digital interface between VAV box and the Building Energy Management System.
- B. Each unit shall be controlled by an electronic room temperature sensor as shown on drawings.
- C. Unit primary air inlet damper shall be modulated between its scheduled minimum and maximum air volumes as required to maintain space temperature.
- D. Provide a modulating, automatic control valve with controls arranged so that when space temperature falls below setpoint and primary air is at a minimum, the control valve on the heating coil will gradually open and reset to maintain space temperature.
- E. Fan shall operate continuously during occupied mode and cycle during unoccupied mode.
- F. Hot water modulating valve shall open/close to provide reheat via reheat coils.

#### 3.5 START-UP/TESTING

- A. The Building Energy Management System shall be started up in phases agreed to by the Owner.
- B. Prior to testing and verifying proper system operation, Contractor shall furnish the Owner and Engineer, for acceptance two (2) copies each of the start-up/testing procedure proposed. Owner and Engineer will review the check-out procedure prior to start-up/testing.
- C. After the procedure is reviewed and after installation is complete and systems are ready to be placed into regular service, Contractor shall inform the Owner of this fact in writing.
- D. Contractor shall agree on a start-up date with Owner and Engineer.
- E. During start-up period Contractor shall have on-site qualified field technicians to place the system in operation, marking such tests, adjustments and changes as may be found necessary to insure successful operation of the installed equipment and systems. All tests shall be documented by the Contractor and certified, verifying that the tests have been performed and that all deficiencies have been corrected. All testing must be performed and all deficiencies corrected to Owner's satisfaction.

# 3.15 TRAINING

- A. At the completion of the project, TCC shall provide 16 hours of training for the Building Energy Management System. The training shall be presented in (4) 4-hour training session.
- B. At the end of the 11<sup>th</sup> month warranty period, TCC shall provide (1) 4-hour training session.

C. TCC shall include in the price of this contract the tuition cost of a one week factory course on operation and maintenance of the system. The owner shall be responsible for transportation and lodging costs.

END OF SECTION 230993

# SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

# 1.1 SECTION REQUIREMENTS

- A. Submittals:
  - 1. Product Data: For each type of product indicated.
  - 2. For solvent cements and adhesive primers, documentation including printed statement of VOC content.

# PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
  - 1. Hot-Water Heating Piping: 150 psig at 200 deg F.
  - 2. Chilled-Water Piping: 150 psig at 200 deg F.
  - 3. Condenser-Water Piping: 150 psig at 150 deg F.
  - 4. Makeup-Water Piping: 80 psig at 150 deg F.
  - 5. Condensate-Drain Piping: 150 deg F.
  - 6. Blowdown-Drain Piping: 200 deg F.
  - 7. Air-Vent Piping: 200 deg F.
  - 8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

# 2.2 PIPES, TUBES, AND FITTINGS

- A. Hard Copper Tubing: ASTM B 88, Type L with ASME B16.22 wrought-copper solder fittings and ASTM B 32, 95-5 tin antimony solder.
- B. Soft Copper Tubing: ASTM B 88, Type K with ASME B16.22 wrought-copper solder fittings.
- C. Steel Pipe: ASTM A 53, Schedule 40, plain ends with malleable-iron threaded fittings, Class 150.
- D. Unions: ASME B16.39, malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
- E. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure, 250 deg F maximum operating temperature.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, ends.

# 2.3 SPECIAL-DUTY VALVES

- A. Calibrated Plug Valves: 150-psig water working pressure, 250 deg F maximum operating temperature; bronze body with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening.
- B. Pressure-Reducing Valves: Diaphragm-operated, cast-iron or brass-body valve, with low-inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem.
- C. Safety Relief Valves: Brass or bronze body with brass and rubber, wetted, internal working parts; to suit system pressure and heat capacity; according to ASME Boiler and Pressure Vessel Code: Section IV.

#### 2.4 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.
- B. Diaphragm-Type Expansion Tanks: Welded carbon steel, 150-psig working pressure, 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled according to ASME Pressure Vessel Code: Section VIII.
- C. Chemical Feeder: 5-gal., bypass-type, welded steel; 150-psig working pressure; complete with fill funnel and inlet, outlet, and drain valves. Furnish chemicals specially formulated to prevent accumulation of scale and corrosion in piping system and connected equipment, developed based on analysis of makeup water.
- D. Y-Pattern Strainers: 150-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated Type 304 stainless-steel basket, and bottom drain connection.

# PART 3 - EXECUTION

# 3.1 INSTALLATION

A. Comply with requirements in Section 230500 "Common Work Results for HVAC" for basic piping installation requirements.

- B. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Comply with requirements in Section 230500 "Common Work Results for HVAC" for wall penetration systems.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping free of sags and bends and install fittings for changes in direction and branch connections.
- E. Use the fewest number of joints belowground and within floor slabs.
- F. Install piping at a uniform slope of 0.2 percent upward in the direction of flow.
- G. Make reductions in pipe sizes using eccentric reducer fitting installed with level side up.
- H. Install branch connections to mains using tee fittings in main with takeoff out the bottom of the main, except for up-feed risers, which shall have swing joint and takeoff out the top of the main line.
- I. Install unions in pipes adjacent to each valve, at final connections with each piece of equipment, and elsewhere as indicated.
- J. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps) and other vibration-producing equipment.
- K. Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before soldering or brazing.
- L. Provide manual air vents at all coil return ports.
- M. Provide 30 gallon diaphragm expansion tank on hot water system with 5 gallon pressure relief.
- N. Provide chemical feeder for hot water system.

# 3.2 VALVE INSTALLATIONS

- A. Shutoff Duty: Use gate or ball valves.
- B. Throttling Duty: Use globe or ball valves.
- C. Install shutoff-duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.
- D. Install throttling-duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- E. Install calibrated plug valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.

- F. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and cap.
- G. Install check valves on each pump discharge and elsewhere as required to control flow direction.
- H. Install safety relief valves on hot-water generators and elsewhere as required by authorities having jurisdiction. Pipe discharge to floor drain without valves.
- I. Install manual air vents at high points in the system, at heat-transfer coils, and elsewhere as required for system air venting.
- J. Run piping from boiler air vent connection or air separator to compression tank with 1/4 inch per foot upward slope towards tank. Connect boiler outlet piping.
- K. Install valves with stem up. Allow clearance above stem for check mechanism removal.

# 3.3 SPECIALTIES INSTALLATIONS

- A. Install chemical feeders in each hydronic system in upright position with top of funnel not more than 48 inches above floor. Install feeder across pump or in bypass line, off main using ball valves on each side of feeder, and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
- B. Install diaphragm-type compression tanks on floor. Vent and purge air from hydronic system; charge tank with proper air charge to suit system design requirements.
- C. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, inline pump, and elsewhere as indicated.

# 3.4 TESTING, ADJUSTING, AND BALANCING

- A. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens.
- B. Hydrostatically test completed piping at a pressure one and one-half times operating pressure. Isolate equipment before testing piping. Repair leaks and retest piping until there are no leaks.
- C. Balance water flow as required by Section 230593 "Testing, Adjusting, and Balancing for HVAC."

# 3.5 PIPING SCHEDULE

- A. Hot and Chilled Water:
  - 1. Aboveground: Drawn-temper copper tubing with soldered joints, or steel pipe with threaded joints.
  - 2. Aboveground: Steel pipe with mechanical grooved joints equal to "Victaulic".

B. Condensate Drain Lines: Drawn-temper copper tubing with soldered joints or PVC pipe with solvent-welded joints.

END OF SECTION 232113

# SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

# 1.2 SUMMARY

- A. Section Includes:
  - 1. Hydronic specialty valves.
  - 2. Air-control devices.
  - 3. Strainers.
  - 4. Connectors.
- B. Related Requirements:
  - 1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
  - 2. Section 230523.11 "Globe Valves for HVAC Piping" for specification and installation requirements for globe valves common to most piping systems.
  - 3. Section 230523.12 "Ball Valves for HVAC Piping" for specification and installation requirements for ball valves common to most piping systems.
  - 4. Section 230523.13 "Butterfly Valves for HVAC Piping" for specification and installation requirements for butterfly valves common to most piping systems.
  - 5. Section 230523.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.
  - 6. Section 230523.15 "Gate Valves for HVAC Piping" for specification and installation requirements for gate valves common to most piping systems.
  - 7. Section 230923.11 "Control Valves" for automatic control valve and sensor specifications, installation requirements, and locations.

# 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product:
  - 1. Include construction details and material descriptions for hydronic piping specialties.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 3. Include flow and pressure drop curves based on manufacturer's testing for calibratedorifice balancing valves and automatic flow-control valves.

#### 1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

#### 1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.
- B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

# PART 2 - PRODUCTS

# 2.1 SOURCE LIMITATIONS

A. Source Limitations: Obtain all grooved joint couplings, fittings, valves, and specialties from single source. Obtain grooving tools from same source as grooved components.

#### 2.2 HYDRONIC SPECIALTY VALVES

- A. Bronze, Calibrated-Orifice, Balancing Valves:
  - 1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
  - 2. Ball: Brass or stainless steel.
  - 3. Plug: Resin.
  - 4. Seat: PTFE.
  - 5. End Connections: Threaded or socket.
  - 6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  - 7. Handle Style: Lever, with memory stop to retain set position.
  - 8. CWP Rating: Minimum 125 psig.
  - 9. Maximum Operating Temperature: 250 deg
- B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
  - 1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
  - 2. Ball: Brass or stainless steel.
  - 3. Stem Seals: EPDM O-rings.
  - 4. Disc: Glass and carbon-filled PTFE.
  - 5. Seat: PTFE.
  - 6. End Connections: Flanged or grooved.
  - 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  - 8. Handle Style: Lever, with memory stop to retain set position.
  - 9. CWP Rating: Minimum 125 psig.
  - 10. Maximum Operating Temperature: 250 deg F.

- C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
  - 1. Body: Bronze or brass.
  - 2. Disc: Glass and carbon-filled PTFE.
  - 3. Seat: Brass.
  - 4. Stem Seals: EPDM O-rings.
  - 5. Diaphragm: EPT.
  - 6. Low inlet-pressure check valve.
  - 7. Inlet Strainer: stainless steel, removable without system shutdown.
  - 8. Valve Seat and Stem: Noncorrosive.
  - 9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- D. Diaphragm-Operated Safety Valves: ASME labeled.
  - 1. Body: Bronze or brass.
  - 2. Disc: Glass and carbon-filled PTFE.
  - 3. Seat: Brass.
  - 4. Stem Seals: EPDM O-rings.
  - 5. Diaphragm: EPT.
  - 6. Wetted, Internal Work Parts: Brass and rubber.
  - 7. Inlet Strainer: stainless steel, removable without system shutdown.
  - 8. Valve Seat and Stem: Noncorrosive.
  - 9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- E. Automatic Flow-Control Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flow Design, Inc.
    - b. Griswold Controls.
    - c. Nexus Valve, Inc.
    - d. NIBCO INC.
    - e. Victaulic Company.
  - 2. Body: Brass or ferrous metal.
  - 3. Flow Control Assembly, provide the following:
    - a. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
  - 4. Combination Assemblies: Include bronze or brass-alloy ball valve.
  - 5. Identification Tag: Marked with zone identification, valve number, and flow rate.
  - 6. Size: Same as pipe in which installed.
  - 7. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.
  - 8. Minimum CWP Rating: 300 psig.
  - 9. Maximum Operating Temperature: 250 deg F.
- F. Triple Duty Valve Assembly:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; MasterSeal butterfly valve with memory stop and a Victaulic Series 779 Venturi-Check, or comparable product by an approved manufacturer:
- 2. Water Service: Rated to 230 deg F.
- 3. Pressure Rating: 300 psi.

# 2.3 AIR-CONTROL DEVICES, EXPANSION TANKS, AND AIR & DIRT SEPARATORS

- A. Manual Air Vents:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AMTROL, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett.
    - d. TACO Comfort Solutions, Inc.
  - 2. Body: Bronze.
  - 3. Internal Parts: Nonferrous.
  - 4. Operator: Screwdriver or thumbscrew.
  - 5. Inlet Connection: NPS 1/2.
  - 6. Discharge Connection: NPS 1/8.
  - 7. CWP Rating: 150 psig.
  - 8. Maximum Operating Temperature: 225 deg F.
- B. Automatic Air Vents:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AMTROL, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett.
    - d. TACO Comfort Solutions, Inc.
  - 2. Body: Bronze or cast iron.
  - 3. Internal Parts: Nonferrous.
  - 4. Operator: Noncorrosive metal float.
  - 5. Inlet Connection: NPS 1/2.
  - 6. Discharge Connection: NPS 1/4.
  - 7. CWP Rating: 150 psig.
  - 8. Maximum Operating Temperature: 240 deg F.
- C. Diaphragm-Type ASME Expansion Tanks:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. AMTROL, Inc.
- b. Armstrong Pumps, Inc.
- c. Bell & Gossett; a Xylem brand.
- d. Flo Fab Inc.
- e. TACO Comfort Solutions, Inc.
- 2. Tank: Welded steel, rated for 150-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- 3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
- 4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- 5. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
- 6. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch diameter gage glass, and slotted-metal glass guard.
- D. Combination Coalescing-Type Air and Dirt Separators:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong Pumps, Inc.
    - b. Bell & Gossett; a Xylem brand.
    - c. Spirotherm, Inc.
  - 2. Full flow coalescing type combination air eliminator and dirt separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels, and include two equal chambers above and below the inlet / outlet nozzles. Flanges to be class 150, raised face, weld neck.
  - 3. Selection shall be based upon system flow with pipe size as a minimum. In no case shall entering velocity exceed 10 feet per second.
  - 4. Unit shall include internally structured coalescing media elements uniformly filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes and capable of 5 micron removal. The elements must be fabricated by the manufacturer and consist of a copper core tube with continuous wound copper wire or 316 stainless steel media permanently attached and followed by a separate continuous wound copper or 316 stainless steel wire permanently affixed. Media packed or assembled in a random or non-uniform manner shall not be acceptable. 3 Year warranty required.
  - 5. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
  - 6. Units shall include a side tap valve to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

- 7. Units shall have a blow down valve capable of eliminating sediment that collects in the bottom of the vessel while in operation.
- 8. Units shall be painted. Units with a primer finish will not be acceptable.
- 9. Reduced vessel size, partial fill, loosely filled rings or elements spaced apart will not be accepted. Vessel diameter and height above and below the inlet/outlet connections must be equal to the basis of design.
- 10. Size: Match system flow capacity.

# 2.4 STRAINERS

- A. Y-Pattern Strainers:
  - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
  - 4. CWP Rating: 125 psig.

# 2.5 CONNECTORS

- A. Stainless Steel Bellow, Flexible Connectors:
  - 1. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
  - 2. End Connections: Threaded or flanged to match equipment connected.
  - 3. Performance: Capable of 3/4-inch misalignment.
  - 4. CWP Rating: 150 psig.
  - 5. Maximum Operating Temperature: 250 deg F.
- B. Factory-Assembled Grooved End Vibration Pump Drops: 3 inches through 12 inches. Orange enamel coated installation-ready assembly with flexible couplings to accommodate vibration attenuation and stress relief. Rated for working pressure to 300-psig.
  - 1. Discharge Drop: Class 150 flange for pump connection, straight line with concentric reducer for vertical pump connections, triple duty valve assembly, and pipe spool with thermometer and pressure ports.
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Series 380 or comparable product by one of the following:
  - 2. Suction Drop: Suction diffuser with stainless steel basket and diffuser and Class 150 flange for pump connection, butterfly valve with offset stem for 360-degree circumferential seating, and pipe spool with thermometer and/or pressure ports.
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic Company; Series 381 or comparable product by one of the following:

# PART 3 - EXECUTION

# 3.1 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install throttling-duty valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
- G. Install full-pipe-size water meter immediately upstream of all pressure-reducing valves on chilled & heating hot water make-up systems. Ensure meter is able to be accessed easily from floor level. Temperature Controls Contractor shall provide for signaling capability back to BMS, to alarm when water meter is experiencing high flow event.
- H. Install automatic flow control valves as shown on drawings.
- I. Install components in accordance with manufacturer's recommendations.

# 3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- D. Install air and dirt separators as shown on drawing and with blowdown piping with gate or fullport ball valve; extend full size to nearest floor drain. These separators are required to be installed for any new chilled water and heating hot water connections to a building, on closed loop hydronic systems involved with renovations, and as otherwise shown on the drawings.
- E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system requirements.
- F. Install strainers upstream of all hydronic, steam condensate, feedwater, etc. pumps. Provide valve & piping from strainer to nearest floor drain.

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END OF SECTION 232116

# SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

### 1.1 SECTION INCLUDES

- A. Vertical in-line pumps
- B. Close-coupled pumps
- C. Base-mounted pumps
- D. In-line circulators

#### 1.2 SUBMITTALS

- A. Product Data. For each type of pump including certified pump-performance curves, furnished specialties, motor horsepower and electrical characteristics.
- B. Operation and maintenance data. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pumps to site, properly store, and protect under applicable provisions of Section 230500.
- B. Store pumps in a dry location.
- C. Retain shipping protective covers on suction and discharge and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Pumps that will be stored for an extended time shall have internal parts and bearings dried and protected from rust in accordance with manufacturer's instructions.
- F. If pumps have to be rigged into place, follow manufacturer's instructions for handling.

### 1.4 EXTRA PARTS

A. Provide (1) extra set of mechanical seals for each type and size pump under provisions of Division 1.

# Vincennes University Green Activities Center Partial Renovations

### 1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

A. Comply with UL 778 for motor-operated water pumps.

#### 2.2 MANUFACTURERS

- A. Grundfos
- B. Bell & Gossett
- C. Armstrong

#### 2.3 HYDRONIC PUMPS

- A. Vertical In-Line Pumps
  - 1. Type: Vertical, single stage, close coupled, radially split casing, for in-line mounting, for 175 psig working pressure.
  - 2. Casing: Cast iron with suction and discharge gage port, drain plug, flanged suction and discharge.
  - 3. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
  - 4. Shaft: Carbon steel with bronze sleeve.
  - 5. Seal: Carbon rotating against a stationary ceramic seat, 225 degrees F maximum continuous operating temperature.
  - 6. Provide ground rings on all pumps Aegis or equal.
- B. Close-Coupled, In-Line Centrifugal Pumps: Factory-assembled and -tested, overhung impeller, designed for installation with pump and motor shafts mounted horizontally or vertically. Rated for 125-psig minimum working pressure and minimum continuous water temperature of 225 deg F.
  - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
  - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
  - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
  - 5. Provide ground rings on all pumps Aegis or equal.

- C. Base-Mounted Pumps
  - 1. Type: Centrifugal, single stage, radially or horizontally split casing, for 175 psig maximum working pressure.
  - 2. Casing: Cast iron, with suction and discharge gage ports and drain plug.
    - a. Renewable bronze casing wearing rings.
  - 3. Impeller: Bronze, fully enclosed, keyed to shaft.
  - 4. Bearings: Re-greaseable ball bearings.
  - 5. Shaft: ASME carbon steel. Replaceable aluminum bronze shaft sleeve
  - 6. Motor: Drip proof of NEMA design. Refer to Section 23 05 13.
  - 7. Seal: Carbon rotating against a stationary ceramic seat 225 degrees F maximum continuous operating temperature.
  - 8. Drive: Flexible coupling with coupling guard.
  - 9. Baseplate: Cast iron or fabricated steel.
    - a. Integral drip lip or galvanized. steel drain pan on chilled water pumps.
  - 10. Provide ground rings on all pumps Aegis or equal.
- D. In-Line Circulators
  - 1. Circulator: Centrifugal, single stage, radially split case horizontal inline, bronze fitted, close-coupled; rated for 175 psig working pressure and 225°F continuous water temperature.
  - 2. Circulator Casing: Cast iron, have suction and discharge gage tappings and vent connections and threaded companion flanges for piping connections smaller than 2-1/2 inches.
  - 3. Impeller: Closed, overhung, single-suction; fabricated from cast bronze, except brass may be used for 1" pumps; statically and dynamically balanced; keyed to shaft.
  - 4. Circulator Bearings: Bronze journal and thrust bearings, oil lubricated.
  - 5. Circulator Shaft: Steel, with copper sleeve. Provide flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering motor bearings.
  - 6. Mechanical Seal: Carbon steel rotating ring, stainless steel spring, ceramic seat, flexible bellows and gasket.
  - 7. Motor: Drip-proof construction with oil lubricated bearings; resiliently mounted to pump casing.
  - 8. Provide ground rings on all pumps Aegis or equal.

# 2.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- B. Less Than 1/2 HP: Built-in thermal-overload protection.
- C. 1/2 to 3 HP: Permanently lubricated ball bearings.
- D. 5 HP and Larger: Grease-lubricated ball bearings.
- E. Motor shall be non-overloading within full range of pump performance.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions effecting performance of pumps.
- B. Examine rough-in for piping systems to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install pumps as shown on drawings, in accordance with manufacturer's written instructions, with proper clearance and access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- B. In-Line Pumps: Suspend, using hanger rods and vibration isolation hangers of sufficient size to support pump weight independent from piping system. Fabricate brackets or supports as required for pumps.
- C. Base-Mounted Pumps: Set on 4" concrete foundation base, set level, grouted in place, and properly isolated to control vibration transmission. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
- D. Vertical In-Line Pumps: Set on 4" concrete foundation base, set level, and properly isolated to control vibration transmission.
- E. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping. For close-coupled or base-mounted pumps, provide supports under suction diffuser on pump suction.
- F. Pump Connections: Decrease piping from line size to pump connection size with long radius reducing elbows or reducers. Provide line size shut-off valve and strainer (suction diffuser) on pump suction. Provide line size check valve and strainer on pump discharge. Provide union or flanged connection at suction and discharge of each pump to enable servicing or isolation of individual pumps.
- G. Flexible Connectors: Provide on suction and discharge side of each base-mounted pump, located between pump casing and discharge valves and upstream from straining device, unless indicated otherwise for a particular installation.
- H. Provide air cock and drain connection on horizontal pump casings.
- I. Provide drains for bases and seals, piped to and discharging into floor drains.
- J. Where multiple pumps are manifolded together, provide interconnecting piping, valves, fittings, meters, gauges, etc.

- K. Provide pressure gages, equipped with gage valves, installed in suction and discharge of each pump.
- L. Lubricate pumps prior to start-up.
- M. Install electrical connections for power, controls, and devices.
- N. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve. Provide for impeller trimming, as necessary, to ensure operation at system's operating point.

# 3.3 PUMP ALIGNMENT

- A. All shaft-coupled rotating machine alignment shall be performed by pump manufacturer's representative at project site.
- B. Pump Manufacturer's Representative shall use a dial indicator to align pumps with less than 20 hp motors.
- C. Pump Manufacturer's Representative shall laser align all pumps with motors that are 20 hp or higher. Laser shaft alignment systems shall be one of the following:
  - 1. Ludeca Aligneo.
  - 2. Rotalign.
  - 3. Rotalign Pro.
  - 4. Optalign Plus.
  - 5. Masterlign.
- D. Pump base shall be clean, level, planar, and rigid.
- E. Soft foot (pump frame distortion) shall be eliminated prior to final alignment.
- F. After alignment is completed, certified report shall be submitted to Architect/Engineer indicating final alignment readings along with project name, pump identification, pump service and pump model number.

END OF SECTION 232123

# SECTION 233113 – METAL DUCTS

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Rectangular ducts and fittings.
  - 2. Round ducts and fittings.
  - 3. Sheet metal materials.
  - 4. Duct liner.
  - 5. Sealants and gaskets.
  - 6. Hangers and supports.

### B. Related Sections:

- 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
- 2. Division 23 Section "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

# 1.2 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

# 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  - 1. Product data.

# PART 2 - PRODUCTS

#### 2.1 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.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 1-4, "Transverse (Girth) 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."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 1-5, "Longitudinal Seams Rectangular Ducts," 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."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 2, "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."

# 2.2 ROUND DUCT AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Lindab Inc.
    - b. McGill AirFlow LLC.
    - c. SEMCO Incorporated.
    - d. Sheet Metal Connectors, Inc.
    - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-2, "Transverse Joints Round Duct," 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.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-1, "Seams Round Duct and Fittings," 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.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and

Figure 3-5, "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."

# 2.3 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 shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; galvanized.
- D. 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.

# 2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, 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 (Substitutions: See Section 016000 Product Requirements):
    - a. CertainTeed Corporation; Insulation Group.
    - b. Johns Manville.
    - c. Knauf Insulation.
    - d. Owens Corning.
  - 2. 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.
  - 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- B. Insulation Pins and Washers:
  - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

- 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick; 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 2-19, "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 buttededge 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. 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.
  - 7. 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.
  - 8. 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.
  - 9. 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.

# 2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. 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: 3 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.
- 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 C 920.
  - 1. General: Single-component, acid-curing, silicone, elastomeric.
  - 2. Type: S.
  - 3. Grade: NS.
  - 4. Class: 25.
  - 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
  - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
  - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

# 2.6 HANGARS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

# 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 according to SMACNA's "HVAC Duct Construction Standards Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. 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.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

## 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. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- D. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 3.4 HANGAR AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum

Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

#### 3.6 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.
- B. Supply Ducts:
  - 1. Ducts Connected to Self-Contained Units, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive 3-inch wg.
    - b. Minimum SMACNA Seal Class: A.
    - c. SMACNA Leakage Class for Rectangular: 6.
    - d. SMACNA Leakage Class for Round and Flat Oval: 3.
  - 2. Ducts connected to RTUs
    - a. Pressure Class: Positive 5–inch wg.
- C. Return Ducts:
  - 1. Ducts Connected to Self-Contained Units, Furnaces, Heat Pumps, and Terminal Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: B.
    - c. SMACNA Leakage Class for Rectangular: 6.
    - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. Exhaust Ducts:
  - 1. Ducts Connected to Fans Exhausting Air:

- a. Pressure Class: Negative 2-inch wg.
- b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
- c. SMACNA Leakage Class for Rectangular: 12.
- d. SMACNA Leakage Class for Round and Flat Oval: 12.
- E. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel.
- F. Liner:
  - 1. Transfer Ducts: Fibrous glass, Type I, 1/2 inch thick.
- G. Elbow Configuration:
  - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-2, "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 2-3, "Vanes and Vane Runners," and Figure 2-4, "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 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-2, "Rectangular Elbows."
    - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-3, "Round Duct Elbows."

- 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: Standing seam.
- H. Branch Configuration:
  - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 2-6, "Branch Connections."
    - a. Rectangular Main to Rectangular Branch: 45-degree entry.
    - b. Rectangular Main to Round Branch: Spin in.
  - 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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. Manual volume dampers.
  - 2. Fire dampers.
  - 3. Radiation dampers.
  - 4. Smoke dampers.
  - 5. Combination fire/smoke dampers.
  - 6. Flange connectors.
  - 7. Turning vanes.
  - 8. Duct-mounted access doors.
  - 9. Flexible connectors.
  - 10. Flexible ducts.
  - 11. Duct accessory hardware.

## 1.2 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  - 1. Product data.
  - 2. Product certificates.
  - 3. Field quality-control test reports.
  - 4. Wiring Diagrams.
  - 5. Warranty: Sample of warranty.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise

indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- D. 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.

#### 2.2 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: ect to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
    - a. Air Balance Inc.; a division of Mestek, Inc.
    - b. Cesco Products; a division of Mestek, Inc.
    - c. Flexmaster U.S.A., Inc.
    - d. Ruskin Company.
  - 2. Standard leakage rating.
  - 3. Suitable for horizontal or vertical applications.
  - 4. Frames:
    - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
    - 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, 0.064 inch thick.
  - 6. Blade Axles: Galvanized steel.
  - 7. Bearings:
    - a. Molded synthetic.
    - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  - 8. Tie Bars and Brackets: Galvanized steel.

### 2.3 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
  - 1. Greenheck Fan Corporation.
  - 2. Ruskin Company.
  - 3. Nailor.
  - 4. Pottorff.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  - 1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
  - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

## 2.4 RADIATION DAMPER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
  - 1. Greenheck Fan Corporation.
  - 2. Ruskin Company.
  - 3. Nailor.
  - 4. Pottorff.
  - 5. Panasonic.
- B. Type: Dynamic; rated and labeled according to UL 555, UL555C and NFPA 90.
- C. Fire Rating: 2 hours, for use in UL floor/ceiling assembly.

- D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners. Contractor shall verify mounting with ceiling and structure type.
- E. Mounting Orientation: Horizontal ceiling mounted.
- F. Blades: Hindged door, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- G. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- H. Unit shall be compatible with scheduled ceiling mounted exhaust fan.

## 2.5 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
  - 1. Air Balance Inc.; a division of Mestek, Inc.
  - 2. Cesco Products; a division of Mestek, Inc.
  - 3. Greenheck Fan Corporation.
  - 4. Nailor Industries Inc.
  - 5. Pottorff.
  - 6. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with mechanically attached corners and mounting flange.
- E. Smoke Detector: Provide and wired by division 26.
- F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-)] thick, galvanized sheet steel.
- G. Leakage: Class I.
- H. Rated pressure and velocity to exceed design airflow conditions.
- I. Mounting Sleeve: Factory-installed, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- J. Damper Motors: Two-position action.
- K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

- 1. 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.
- 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC."
- 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
- 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
- 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
- 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
- 7. Electrical Connection: 115 V, single phase, 60 Hz.
- L. Accessories:
  - 1. Auxiliary switches for position indication.
  - 2. Test and reset switches, remote mounted.

## 2.6 COMDINATION FIRE/SMOKE DAMPERS

- A. Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):
  - 1. Greenheck Fan Corporation.
  - 2. Nailor Industries Inc.
  - 3. Ruskin Company.
  - 4. Nailor.
  - 5. Pottorff.
- C. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- D. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- E. Fire Rating: 1-1/2 hours.
- F. Frame: Multiple-blade type Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-(0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
- G. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

- H. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
- I. Smoke Detector: Provide and wired by division 26.
- J. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
- K. Leakage: Class I class.
- L. Rated pressure and velocity to exceed design airflow conditions.
- M. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- N. Damper Motors: Two-position action.
- O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. 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.
  - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Division 26 Sections.
  - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
  - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
  - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).
  - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- P. Accessories:
  - 1. Auxiliary switches for position indication.
  - 2. Test and reset switches, remote mounted.
- Q. Accessories:
  - 1. Auxiliary switches for position indication.
  - 2. Test and reset switches, remote mounted.

### 2.7 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Ductmate Industries, Inc.
  - 2. Nexus PDQ; Division of Shilco Holdings Inc.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

## 2.8 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):
  - 1. Ductmate Industries, Inc.
  - 2. METALAIRE, Inc.
  - 3. SEMCO Incorporated.
  - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: 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"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall.

## 2.9 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):
  - 1. American Warming and Ventilating; a division of Mestek, Inc.
  - 2. Cesco Products; a division of Mestek, Inc.
  - 3. Ductmate Industries, Inc.
  - 4. Greenheck Fan Corporation.

- 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
  - 1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.
  - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  - 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.
    - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

#### 2.10 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. Ventfabrics, Inc.
  - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd..
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.

#### 2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.

- 3. Elgen Manufacturing.
- 4. Ventfabrics, Inc.
- 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
  - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- F. 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. (810 g/sq. m).
  - 2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

## 2.12 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 – Product Requirements):
  - 1. Flexmaster U.S.A., Inc.
  - 2. McGill AirFlow LLC.
  - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 175 deg F.

## 2.13 DUCT ACCESSORY HARDWARE

A. 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.

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B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install 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.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire dampers according to UL listing.
- G. Install radiation dampers according to UL listing.
- H. Install smoke dampers according to UL listing.
- I. Install fire/smoke dampers according to UL listing.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 2. Adjacent to and close enough to fire or smoke 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.
  - 3. Upstream from turning vanes.
  - 4. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
- L. Install flexible connectors to connect ducts to equipment.
- M. Connect terminal units to supply ducts directly. Do not use flexible ducts to change directions.
- N. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped

in place.

- O. Connect flexible ducts to metal ducts with liquid adhesive plus tape.
- P. Install duct test holes where required for testing and balancing purposes.

## 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 purpose of access door can be performed.
  - 3. Operate fire and fire/smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  - 4. Inspect turning vanes for proper and secure installation.
  - 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

# SECTION 233600 - VARIABLE AIR VOLUME UNITS

## Part 1- General

## 1.01 DELIVERY AND STORAGE:

Units shall be stored and handled per manufacturer's recommendations.

## 1.02 QUALITY ASSURANCE:

- A. Insulation shall meet NFPA-90A requirements for flame spread and smoke generation and UL-181 requirements for anti-erosion, corrosion and fungus properties.
- B. Hot water coils, when specified, shall be tested for leakage at 250 psig with the coil submerged in water.
- C. Electric heating coils, when specified shall be UL or ETL listed and designed to comply with UL Standard 1096.
- D. Sound power levels shall be AHRI certified in accordance with the requirements of AHRI-880-11.

## 1.03 DELIVERY AND STORAGE:

Units shall be stored and handled per manufacturer's recommendations.

## Part 2 – Products

### 2.01 Equipment

A. General:

Factory-assembled, externally powered, variable air volume control terminal. Unit shall be complete with a damper assembly, flow sensor, externally mounted volume controller, collars for duct connection and all required features. Control box shall be clearly marked with an identification label that lists such information as nominal cfm, maximum and minimum airflow limits, coil type and coil hand, where applicable

## B. Unit Cabinet:

- 1. Constructed of 22-gage galvanized steel with round or rectangular inlet collar and rectangular discharge with slip and drive connection. All primary air inlet collars shall accommodate standard flex duct sizes
- 2. Unit casing shall be lined with 1/2" thick, 1 1/2 lb. dual density fiberglass insulation that meets UL 181 and NFPA 90A. Insulation shall be attached to the unit casing by adhesive and weld pins.
- C. Damper Assembly:

The control air damper assembly shall be constructed of heavy gauge galvanized steel with solid shaft rotating in Delrin® bearings. Damper shaft shall be marked on the end to indicate damper position. Damper blade shall incorporate a flexible gasket for tight airflow shutoff and operate over a full 90°.

D. Controls:

Units shall have pressure-independent pneumatic, electronic, or communicating controls, as specified, capable of maintaining required airflow set points +/-5% of the unit's capacity at any inlet pressure up to 6-in. wg. The controllers shall be capable of resetting between factory or field-set maximum and minimum (>350 fpm inlet duct velocity) set points to satisfy the room thermostat

## demand.

The unit shall be equipped with an amplified flow probe located in the unit inlet. Air flow for the pressure independent controller (supplied by others) shall be determined with a factory supplied 12 point total pressure, center averaging cross flow sensor, having a magnification resulting in no greater than 2625 fpm @ 1" developed signal.

## E. Accessories:

1. Hot Water Heating Coil:

Coil shall be mounted in a minimum 20 Ga. Galvanized steel casing with slip and drive discharge connections, and factory mounted on the base unit as shown on the equipment drawings. Coils shall have:

- a. Aluminum fins (10 ft/in.) bonded to the copper tubes by mechanical expansion.
- b. Number of coil rows and circuits shall be selected to provide performance as required by the plans.
- c. Up to 4 rows as shown on equipment drawings or designed on the equipment schedule. Right or left-hand fittings with sweat connection sizes as indicated on equipment drawings.
- 2. Electric Heating Coil:

Electric coils shall be supplied by the terminal unit manufacturer and shall be UL listed. Construct coil casing with minimum of 20-gage zinc coated steel. Elements shall be nickel chrome and supported by ceramic isolators. The integral control panel shall be housed in a NEMA 1 enclosure, with access door to all controls and safety devices. Electric coils shall contain a primary automatic reset thermal cutout and differential pressure airflow switch for proof of airflow. Heaters shall be:

- a. Designed for the capacity, electrical characteristics and steps of control as shown on the equipment schedule
- b. Open coil construction with 80% nickel, 20% chromium wire supported in free-floating ceramic bushings. Coil frame shall be constructed of corrosion resistant steel.
- c. Factory wired and include all limit switches
- 3. Multiple Outlet Attenuator:

Multiple Outlet Attenuator shall be 36 in. long and factory installed on the non-attenuated base unit that is not equipped with electric heat. Refer to equipment schedule for effected units. The octopus shall be:

- a. Equipped with 6-in. or 8-in. diameter collars in the quantity and configuration specified on the equipment drawings. Each collar shall include a locking butterfly balancing damper.
- b. Insulated with -in thick, 1.5-lb. equivalent dual density or mat-faced insulation
- 4. Sound Attenuator:

The integral sound attenuator section shall consist of a continuous extension of the standard zinc coated steel casing. When electric heat is required, the attenuator will be used as a standard feature.

## F: Performance:

1. The pressure drop through the units shall not exceed scheduled values, including hot water coils.

#### 2. Acoustical Requirement

2.1 Unit supplied shall be rated in accordance with AHRI 880 certification program at the rated flow rates and pressures. The unit manufacturer shall furnish octave band sound power data for both casing radiated and discharge sound levels with the selected lining and above flow sensor, as tested per AHRI Industry Standard 880-11, at the required flow rates and inlet pressures. Both Discharge and Radiated sound data shall result in room Sound Pressure levels not to exceed those listed below, with a tolerance of + 2 dB in any band for less than 20% of the units, when determined in accordance with AHRI 885-08 Appendix E with the following listed assumptions:

2.2 Desired Room Sound Pressure level, dB by Octave Band:

Sound Criteria	: High Speech Privacy									
Octave Band	:	2	3	4	5	6	7			
Room Sound Pressure	:	57	53	48	43	37	31			

2.3 Application Assumptions Nominal Duct Size = 12. Nominal Duct Ps = 1.0.

----- Discharge Sound Assumptions -----Sound Power Division based on 2 Power Splits 5 Ft. of Lined Duct 5 feet of 8" Flexible duct End Reflection based on a 10" round duct.

Room Absorption based on a 2400 CuFt room, 5 Ft from the source: Octave Band : 2 3 4 5 6 7 Room Effect, dB : 5 7 8 9 10 11

----- Radiated Sound Assumptions ------

AHRI 885-08 assumes that ceiling located sound sources are not point, but area sources, and the room attenuation is included in the ceiling/space effect, based on the ceiling tile selected.

Ceiling: AHRI 885-08 Type 2, 10 pcf Mineral Tile Octave Band : 2 3 4 5 6 7 Total Space Effect : 15 17 19 25 30 33

2.4 Maximum Allowable Sound Power

Based on the assumptions in section 2.3 above, neither Radiated or Discharge Unit sound power shall exceed the following levels at an inlet pressure of 1.0" w.g.:

Octave Ban	ıd	:	2	3	4	5	6	7
Radiated Pwl	,dB	:	74	71	67	68	67	64
Discharge Pwl	,dB	:	79	78	82	90	87	65

## G. DEMONSTRATION AND TRAINING

A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

# H. WARRANTY

A. Warranty shall be a 1-year factory warranty for parts and labor for the complete unit, and a 5year factory warranty on compressor(s). Warranty shall start 6 months after shipment, or when the unit start-up is performed, whichever is sooner.

END OF SECTION 233600

## SECTION 233713 – DIFFUSERS, REGISTERS, AND GRILLES

## PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Rectangular and square ceiling diffusers.
  - 2. Louver face diffusers.
  - 3. Adjustable bar registers and grilles.
  - 4. Fixed face registers and grilles.
- B. Related Sections:
  - 1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
  - 2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volumecontrol dampers not integral to diffusers, registers, and grilles.

### 1.2 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
  - 3. Color chart.
- B. Samples: For each exposed product and for each color and texture specified.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.
  - 1. Product data.
  - 2. Product certificates.
  - 3. Source quality-control reports.
  - 4. Field quality-control reports.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following (Substitutions: See Section 016000 Product Requirements):
  - 1. Anemostat.
  - 2. Krueger.
  - 3. Metalaire.
  - 4. Price.
  - 5. Titus.
  - 6. Tuttle & Bailey.
  - 7. Nailor.
- B. Provide thermally adjustable diffusers manufactured by Acutherm.

#### 2.2 CEILING DIFFUSERS

- A. Square Ceiling Diffusers:
  - 1. As specified on drawing schedule.

#### 2.3 DUCT DIFFUSERS

- A. Duct Diffusers:
  - 1. As specified on drawing schedule.

## 2.4 REGISTERS AND GRILLES

- A. Return/Transfer Grille:
  - 1. Grilles shall be of aluminum construction, consisting of aluminum 1/2" x 1/2" x 1/2" grid and an extruded aluminum border.
  - 2. The grille shall be finished in B12 White Powder Coat.

### 2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as 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, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

#### 3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

# SECTION 237413 – AIR HANDLING UNIT

## PART 1 - GENERAL

Furnish and install KRUEGER KBH Blower Coil Units where indicated on the plans and specifications. Units shall be completely factory assembled and tested and shipped as one piece except where noted.

All units shall be capable of meeting or exceeding the scheduled capacities for cooling, heating and air delivery. All unit dimensions for each model and size shall be considered maximums.

All units shall be of "draw-thru" design with coils, fans, motor, and drain pan completely contained within the unit cabinet.

Electric heat to be in the blow-thru configuration.

Units shall be cETL listed in compliance with UL/ANSI Std. 1995.

All unit coils shall meet or exceed the scheduled cooling and heating capacity, selected and rated in accordance with AHRI 410.

#### PART 2 – CONSTRUCTION

All units shall be fabricated of minimum 18 gauge galvanized steel, able to withstand a 125 hour salt spray test per ASTM B-117. Panels shall be die-formed "multibend" construction for optimum strength and rigidity.

All exterior panels shall be single wall insulated with 1 inch thick fiberglass insulation, rated for a maximum air velocity of 5000 f.p.m.

Single wall with 1" thick, 1.6 pound per cubic foot density scrim reinforced foil faced insulation.

Insulation must meet all requirements of ASTM C1071 (including C665), UL181 for erosion, and carry a 25/50 rating for flame spread/smoke developed per ASTM E-84, UL723 and NFPA 90A. In addition to using adhesive complying with NFPA 90A, the insulation shall incorporate a secondary mechanical fastener attached to the unit casing wall. Adhesive as the only method of fastening the insulation to the casing is not acceptable.

All access panels shall be fully insulated and attached with standard fasteners on at least two opposite sides. No single access panel shall be larger than 30" x 36" for safety and ease of handling. No coil or drain piping or electrical connections shall pass through any access panel.

Each unit shall be furnished with a one-piece heavy gauge IAQ stainless steel drain pan with welded corner construction. Drain pan shall be insulated with minimum 1/8" closed cell foam. All units shall be provided with 9/16" diameter hanger rod holes in the top and bottom panels for "through-bolt" type suspension installation.

Spring type unit mounting vibration isolators shall be provided by the unit manufacturer.

All units shall have a minimum 1" duct collar on both the discharge and return.

## PART 3 - FAN & MOTOR ASSEMBLY

All units shall be furnished with double inlet forward curved centrifugal blowers statically and dynamically balanced for smooth operation. Blower wheels shall be mounted directly on the motor shaft. Belt driven blowers are not acceptable.

Fan motors shall be electronically commutated with thermal overload protection and a constant torque operation. RPM control shall not be acceptable. Motors shall feature permanently lubricated ball bearings and operate on three or single phase power.

All motors to be installed, factory programmed and wired to the control panel.

All motors shall be isolated, depending on motor size, via belly band or torsion flex mount to the blower housing.

All motor wiring is to be terminated in a junction box, external to the unit casing.

All motors to be operated by single-speed or multi-speed local or remote controller.

## PART 4 – COILS

All unit coils shall be rated in accordance with AHRI 410.

All coils shall be 1/2" O.D. seamless copper tubes with collared aluminum fins. All tubes shall be mechanically expanded to provide an efficient bond between tube and fin. All water coils shall be provided with a manual air vent fitting to allow for coil venting. Valve core type vent fittings shall not be accepted.

All chilled water, hot water, and direct expansion (DX) coils shall have aluminum fins and 0.016" tube wall thickness.

All coils shall be hydrostatically tested with air under water at 450 PSIG minimum pressure and rated for a maximum of 450 PSIG working pressure at 200°F.

All steam coils shall have 0.025" tube wall thickness.

All steams coils shall be suitable for 15 PSIG maximum operating pressure.

## PART 5 - FILTER RACK ASSEMBLY

All units shall be furnished with a flat filter rack with hinged access on both sides designed to accept a 2" nominal standard sized filters. All units shall be provided with nominal 2" MERV 8 filters factory installed. One complete set of spare MERV 8 filters shall be provided for each unit.

PART 6 - INLET DAMPER SECTION

Where shown on the plans, the unit manufacturer shall furnish a fully insulated mixing box section (factory assembled and installed inlet damper section) to be mounted next to the unit on base rail (unit & mixing box).

The mixing box section shall include heavy gauge formed steel blade dampers in a heavy gauge steel frame with extruded vinyl blade seals and flexible metal jamb seals. Damper drive linkage shall be factory furnished and installed by the unit manufacturer. A field furnished and installed damper actuator can be mounted directly to the damper shaft.

# PART 7 - ELECTRICAL CONTROL

The unit fan motor shall be completely factory wired to an external electrical enclosure. Each unit shall include fan control package with 24 volt control voltage. Each unit shall include a motor control board, motor circuit fusing, control circuit transformer and terminal strip for connection of field wiring.

Motor Control Board: Motor control shall be provided by a single speed or proportional speed controller mounted on the exterior surface of the control box. Opening the control box to adjust the fan speed shall not be required.

Calibrated airflow curves shall be provided near the control box to aid in testing and balancing.

A main incoming power non-fused disconnect switch with lock-out-tag-out ready feature shall be factory furnished and wired by the unit manufacturer for single point power connection.

## PART 8 - TRAINING

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, & maintain the entire unit. Training to occur at Substantial Completion.

## PART 9 – WARRANTY

Warranty shall be a 1-year factory warranty for parts and labor for the complete unit, and a 5-year factory warranty on compressor(s). Warranty shall start 6 months after shipment, or when the unit start-up is performed, whichever is sooner.

END OF SECTION 237413

# SECTION 237423 – PACKAGED ROOFTOP VENTILATORS WITH ENERGY RECOVERY

PART 1 - GENERAL

### 1.1 SUMMARY

- A. This section includes units with integral heating and cooling for outdoor installation. Integral Energy Recovery device shall be a rotary air-to-air total enthalpy wheel. Integral heat source shall be hot water. Integral cooling source shall be packaged DX. Airflow arrangement shall be Outdoor Air with Recirculation. Each unit shall be constructed in a horizontal configuration and shall incorporate additional product requirements as listed in Section 2 of this specification.
- B. Related sections include the following:
  - 1. Section 22 0000: Scope of Work
  - 2. Section 22 0100: General Provisions
  - 3. Section 22 0700: Insulation
  - 4. Section 22 1000: Plumbing
  - 5. Section 23 0900: Controls and Instrumentation
  - 6. Section 23 0000: Electrical

## 1.2 SUBMITTALS

- A. Product Data: For each type or model include the following:
  - 1. Complete fan performance curves for Supply Air [ and Exhaust Air], with system operating conditions indicated as tested on an AMCA Certified Chamber.
  - 2. Sound performance data for Supply Air and Exhaust Air as tested on an AMCA Certified chamber.
  - 3. Motor ratings, electrical characteristics, motor and fan accessories.
  - 4. Performance ratings for all chilled water & DX coils.
  - 5. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
  - 6. Estimated gross weight of each installed unit.
  - 7. Installation, Operating and Maintenance manual (IOM) for each model.
  - 8. Microprocessor Controller (DDC) specifications to include available options and operating protocols. Include complete data on all factory-supplied input devices.
  - 9. Color chart including a palette of available standard paint finishes.
  - 10. Energy recovery performance data for both summer and winter operation.

## 1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain unit with all appurtenant components or accessories from a single manufacturer.
- B. For the actual fabrication, installations, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.
- C. Product Options: Drawings must indicate size, profiles, and dimensional requirements of Energy Recovery Unit and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".
- D. End of line test with full report available upon request.
- E. Certifications
  - 1. Entire unit shall be ETL Certified per U.L. 1995 and bear an ETL sticker.

- 2. Energy Recovery Device shall be AHRI Certified per Standard 1060.
- 3. Coils shall be Recognized Components for ANSI/UL 1995, CAN / CSA C22.2 No 236.05.

## 1.4 COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.
- B. Coordinate location of water system fittings to ensure correct positioning for connection to the water coil and condensate drain pipe.
- C. Coordinate sequencing of construction of associated plumbing, HVAC, electrical supply roofing contractor.

## 1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: (1) set of MERV 8 disposable filters for each unit.
  - 2. One set of energy wheel belts.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include but are not limited to:
  - 1. Valent Air Management Systems

# 2.2 MANUFACTURED UNITS

A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, downturn outdoor air intake with 1" aluminum mesh filter assembly, exhaust air blower, evaporator coil, condensate drain pan, P trap, Energy wheel, hot water coils, hot gas reheat coil, packaged DX system, phase and brownout protection, motorized dampers, motorized recirculating damper, sensors, service receptacle, filter assembly for intake air, supply air blower assembly exhaust air blower assembly filter assembly for exhaust air and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection.

# 2.3 CABINET

- A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
  - Unit's exterior shall be supplied from the manufacturer using G60 galvanneal steel with proprietary pre-painted material in the following finish color; Concrete Gray-RAL 70023. This has been subjected to a salt spray test per ASTM-B117 and evaluated using ASTM-D714 and ASTM-D610 showing no observable signs of rust or blistering until reaching 2,500 hours. This is Valent's Permatector<sup>TM</sup> option. Uncoated galvanized steel exterior is not acceptable
  - 2. Internal assemblies: [22] -gauge, galvanized (G90) steel] except for motor supports which shall be minimum14-gauge galvanized (G90) steel.
- B. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
  - 1. Materials: Rigid urethane injected foam. Foam board not acceptable. a) Thickness: 2 inch (50.8 mm)

- b) Thermal Resistance: R13
- c) Thermally broken
- d) Meets UL94HF-1 flame requirements
- e) Location and application: Full coverage of entire exterior to include walls, roof of unit, unit base and doors
- 2. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
  - a) Thickness: 2 inch (50.8 mm)
  - b) Thermal Resistance: R8
  - c) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
  - d) Location and application: Divider panels between outdoor air and return air/exhaust air streams.
- C. Roof Insulation: 2 inch (50.8 mm) fiberglass located above the 1 inch (25.4 mm) foam panel. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18-gauge galvanized G90 steel or painted galvannealed steel.
- D. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and directdrive fan(s). Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor(s) shall be capable of continuous speed modulation and controlled by a VFD.
- E. Exhaust Air blower assemblies: Blower assembly shall consist of an electric motor a directdrive fan. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor shall be capable of continuous speed modulation and controlled by a VFD.
- F. Evaporator Coil: Evaporator coil shall be (silver) soldered or brazed into the compressed refrigerant system. Coil shall be constructed of copper tubing, permanently bonded to aluminum fins, and enclosed in a galvanized steel frame. If two compressors are used as components of the unit, then the evaporator coil shall be of "interlaced" configuration, permitting independent operation of either compressor without conflict with the other compressor.
- G. Control panel / connections: Rooftop Ventilator units shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections. RTU shall be equipped with a Unit Disconnect Switch.
- H. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded austenitic stainless-steel sheet material and provided with a welded stainless-steel drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.
- I. P trap: If the unit is equipped with a condensate drain pan, contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices.
- J. Energy wheel: Unit energy wheel shall be sized for the full volume of outdoor and exhaust air without an energy wheel bypass damper(s). Bypass dampers are only acceptable during economizer operation they cannot be used during normal operation. Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt or a link style belt with a five-year warranty. The wheel media shall be a polymer film matrix in a stainless-steel framework and be comprised of individual segments that are removable for servicing. Non-

segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and is designed and constructed to permit cleaning and servicing. The energy wheel is to have a five-year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.

- K. Wheel Frost Control: Modulating Wheel: Shall be provided for frost control of the energy wheel. Control system shall include an energy wheel VFD, outdoor air thermostat, and pressure sensor on the wheel assembly to initiate frost control sequence. On/off control based on wheel temperature not acceptable.
- L. Hot water coil(s) shall be factory installed and meet the design requirements as above.
- M. Reheat Coil with factory installed modulating hot gas reheat valve
- N. Packaged DX System: Unit shall have an integral compressor(s) and evaporator coil located within the weather-tight unit housing. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit. The lead refrigerant compressor shall be inverter hermetic scroll-type. Compressors shall be equipped with liquid line filter drier, expansion valve, manual reset high pressure and low-pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with R-410A refrigerant. Compressors shall be mounted within an insulated access compartment and on a raised cabinet shelf to reduce sound and vibration. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.
- O. Condenser Fans: Fan blades must be constructed of aluminum or a composite material and have a geometry designed and documented to reduce sound and energy when compared to a traditional rectangular blade fan. Traditional rectangular blade fans are not allowed due to increased noise generated and increase power utilized. Condenser fan motors shall be three phase, external rotor, type 56 frame, open air over and shaft up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Lead condenser fan(s) will have an electronically commutated (EC) motor that will modulate to maintain a head pressure set point. Motors shall be UL Recognized and CSA Certified. Single condenser fan running at max RPM and design static pressure shall not exceed an A-weighted sound power level of 75 db at free inlet/outlet test conditions.]
- P. DX Control and Diagnostics: The DX system shall be controlled by an onboard digital controller (DDC) that indicates both owner-supplied settings and fault conditions that may occur. The DDC shall be programmed to indicate the following faults:
  - 1. Global alarm condition (active when there is at least one alarm)
  - 2. Supply Air Proving alarm
  - 3. Compressor Trip alarm
  - 4. Compressor Locked Out alarm
  - 5. Supply Air Temperature Low Limit alarm
    - a) Sensor #1 Out of Range (outside air temperature)
    - b) Sensor #2 Out of Range (supply air temperature)
    - c) Sensor #3 Out of Range (cold coil leaving air temperature)]
- Q. Phase and brownout protection: RTU shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.
- R. Motorized dampers / Outdoor Air, Return Air: AMCA Class 1A certified motorized damper of low leakage type and a leakage rate of 3 CFM/ft<sup>2</sup> @ 1 in. wg. shall be factory installed.
- S. AMCA Class 1A motorized recirculating air damper designed to permit 100% maximum recirculation of return air shall be factory installed.
- T. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed as specified by the A/E.

- U. Horizontal connections through unit only. Plenum curb for horizontal connections is not acceptable.
- V. Service receptacle: 120 VAC GFCI service outlet shall be factory-provided and installed. Unit contains a 120 VAC transformer to provide power to service outlet.
- W. Hail guards: Protects the condensing coil from damage due to extreme weather conditions such as hail and flying debris.

# 2.4. BLOWER

- A. Blower section construction: direct drive motor and blower shall be assembled on a 14-gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.
- B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
- C. Fan: Direct drive, backwards curved, airfoil plenum fan with aluminum wheel statically and dynamically balanced. Prop or belt-drive fan not acceptable due to low static capabilities.
- D. Blades: Welded aluminum or painted steel blades only.
- E. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency.

## 2.5. MOTORS

- A. General: Blower motors greater than 1/2 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure.
- B. Motors shall be 60 cycle, 3 phase 460 volts.

# 2.6 UNIT CONTROLS

- A. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors, or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.
- B. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.
- C. RTU supply fan shall be configured for Single Zone VAV
- D. Exhaust fan shall be configured for Supply Tracking
- E. Outside Air / Return Air damper control shall be CO2 sensor by factory.
- F. Economizer control shall be temperature / enthalpy
- G. Operating protocol: The DDC shall be factory-programmed for BACnet MSTP
- H. Variable Frequency Drive (VFD) unit shall have factory installed variable frequency drive for modulation of the supply air blower assemblies & exhaust air blower assemblies. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.

- I. Room thermostat shall be provided as a shipped loose item. The room thermostat shall have an LCD display to adjust the room temperature set point from within the space. The room thermostat shall average 1temperature sensor and 1 relative humidity sensor.
- J. A web user-interface (web UI) must be available for the manufacturer installed controls. The interface can be accessed via a web browser (when an Ethernet cable is connected to the building network) or to a laptop plugged in directly to the controller. Web UI must have the following features available which allow simple access to the unit, improved startup / commissioning and provide quick troubleshooting capabilities:
  - Graphical overview screen for easy access to current conditions and set point changes
  - All sensor values, set point and control outputs recorded each minute with 1 week of history stored on the controller for simple troubleshooting
  - Refrigeration details screen with compressor status, temperature and pressure readings
  - Access to current alarms and alarm history
  - Service override capabilities to manually change I/O and verify proper operation of the unit

## 2.7 FILTERS

A. Unit shall have permanent 1 inch (25.4 mm) aluminum mesh filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 8 disposable pleated filters shall be provided in the supply final air stream and MERV 8 filters in the exhaust air stream.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
- B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.

## 3.3 CONNECTIONS

- A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
  - 1. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings and specialties.
  - 2. Duct installation and connection requirements are specified in Division 23 of this document.
  - 3. Electrical installation requirements are specified in Division 26 of this document.

# 3.4 FIELD QUALITY CONTROL

Vincennes University Green Activities Center Partial Renovations

A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

## 3.5 START-UP SERVICE

A. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

## 3.6 DEMONSTRATION AND TRAINING

- A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.
- X. rate of  $3 \text{ CFM/ft}^2 @ 1$  in. wg. shall be factory installed.
- Y. AMCA Class 1A motorized recirculating air damper designed to permit 100% maximum recirculation of return air shall be factory installed.
- Z. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed as specified by the A/E.
- AA. Horizontal connections through unit only. Plenum curb for horizontal connections is not acceptable.
- BB.Service receptacle: 120 VAC GFCI service outlet shall be factory-provided and installed. Unit contains a 120 VAC transformer to provide power to service outlet.
- CC. Hail guards: Protects the condensing coil from damage due to extreme weather conditions such as hail and flying debris.

# 2.4. BLOWER

- F. Blower section construction: direct drive motor and blower shall be assembled on a 14-gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.
- G. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
- H. Fan: Direct drive, backwards curved, airfoil plenum fan with aluminum wheel statically and dynamically balanced. Prop or belt-drive fan not acceptable due to low static capabilities.
- I. Blades: Welded aluminum or painted steel blades only.
- J. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency.

# 2.5. MOTORS

- C. General: Blower motors greater than 1/2 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure.
- D. Motors shall be 60 cycle, 3 phase 460 volts.

# 2.6 UNIT CONTROLS

- K. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors, or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.
- L. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.
- M. RTU supply fan shall be configured for Duct Static Pressure
- N. Exhaust fan shall be configured for Supply Tracking
- O. Outside Air / Return Air damper control shall be CO2 sensor by factory.
- P. Economizer control shall be temperature / enthalpy
- Q. Operating protocol: The DDC shall be factory-programmed for BACnet MSTP
- R. Variable Frequency Drive (VFD) unit shall have factory installed variable frequency drive for modulation of the supply air blower assemblies & exhaust air blower assemblies. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
- S. Room thermostat shall be provided as a shipped loose item. The room thermostat shall have an LCD display to adjust the room temperature set point from within the space. The room thermostat shall average 1 temperature sensor and 1 relative humidity sensor.
- T. A web user-interface (web UI) must be available for the manufacturer installed controls. The interface can be accessed via a web browser (when an Ethernet cable is connected to the building network) or to a laptop plugged in directly to the controller. Web UI must have the following features available which allow simple access to the unit, improved startup / commissioning and provide quick troubleshooting capabilities:
  - Graphical overview screen for easy access to current conditions and set point changes
  - All sensor values, set point and control outputs recorded each minute with 1 week of history stored on the controller for simple troubleshooting
  - Refrigeration details screen with compressor status, temperature and pressure readings
  - Access to current alarms and alarm history
  - Service override capabilities to manually change I/O and verify proper operation of the unit

# 2.7 FILTERS

B. Unit shall have permanent 1 inch (25.4 mm) aluminum mesh filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 8 disposable pleated filters shall be provided in the supply final air stream and MERV 8 filters in the exhaust air stream.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
- B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

B. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.

# 3.3 CONNECTIONS

- B. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
  - 4. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings and specialties.
  - 5. Duct installation and connection requirements are specified in Division 23 of this document.
  - 6. Electrical installation requirements are specified in Division 26 of this document.

# 3.4 FIELD QUALITY CONTROL

B. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

# 3.5 START-UP SERVICE

B. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

# 3.6 DEMONSTRATION AND TRAINING

B. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

# 3.7 WARRANTY

A. Warranty shall be a 1-year factory warranty for parts and labor for the complete unit, and a 5year factory warranty on compressor(s). Warranty shall start 6 months after shipment, or when the unit start-up is performed, whichever is sooner.

END OF SECTION 237423

# SECTION 237424 – PACKAGED ROOFTOP VENTILATORS

PART 1 - GENERAL

# 1.1 SUMMARY

- A. This section includes units with integral heating and cooling for outdoor installation. Integral cooling source shall be packaged DX. Airflow arrangement shall be Outdoor Air with Recirculation. Each unit shall be constructed in a horizontal configuration and shall incorporate additional product requirements as listed in Section 2 of this specification.
- B. Related sections include the following:
  - 1. Section 22 0000: Scope of Work
  - 2. Section 22 0100: General Provisions
  - 3. Section 22 0700: Insulation
  - 4. Section 22 1000: Plumbing
  - 5. Section 23 0900: Controls and Instrumentation
  - 6. Section 23 0000: Electrical

# 1.2 SUBMITTALS

- A. Product Data: For each type or model include the following:
  - 1. Complete fan performance curves for Supply Air [ and Exhaust Air], with system operating conditions indicated as tested on an AMCA Certified Chamber.
  - 2. Sound performance data for Supply Air and Exhaust Air as tested on an AMCA Certified chamber.
  - 3. Motor ratings, electrical characteristics, motor and fan accessories.
  - 4. Performance ratings for all chilled water & DX coils.
  - 5. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
  - 6. Estimated gross weight of each installed unit.
  - 7. Installation, Operating and Maintenance manual (IOM) for each model.
  - 8. Microprocessor Controller (DDC) specifications to include available options and operating protocols. Include complete data on all factory-supplied input devices.
  - 9. Color chart including a palette of available standard paint finishes.
  - 10. Energy recovery performance data for both summer and winter operation.

# 1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain unit with all appurtenant components or accessories from a single manufacturer.
- B. For the actual fabrication, installations, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.
- C. Product Options: Drawings must indicate size, profiles, and dimensional requirements of Energy Recovery Unit and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".
- D. End of line test with full report available upon request.
- E. Certifications
  - 1. Entire unit shall be ETL Certified per U.L. 1995 and bear an ETL sticker.
  - 2. Energy Recovery Device shall be AHRI Certified per Standard 1060.

3. Coils shall be Recognized Components for ANSI/UL 1995, CAN / CSA C22.2 No 236.05.

# 1.4 COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.
- B. Coordinate location of water system fittings to ensure correct positioning for connection to the water coil and condensate drain pipe.
- C. Coordinate sequencing of construction of associated plumbing, HVAC, electrical supply roofing contractor.

# 1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: (1) set of MERV 8 disposable filters for each unit.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include but are not limited to:
  - 1. Valent Air Management Systems

# 2.2 MANUFACTURED UNITS

A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, downturn outdoor air intake with 1" aluminum mesh filter assembly, evaporator coil, condensate drain pan, P trap, hot gas reheat coil, packaged DX system, phase and brownout protection, motorized dampers, motorized recirculating damper, sensors, service receptacle, filter assembly for intake air, supply air blower and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection.

# 2.3 CABINET

- A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
  - Unit's exterior shall be supplied from the manufacturer using G60 galvanneal steel with proprietary pre-painted material in the following finish color; Concrete Gray-RAL 70023. This has been subjected to a salt spray test per ASTM-B117 and evaluated using ASTM-D714 and ASTM-D610 showing no observable signs of rust or blistering until reaching 2,500 hours. This is Valent's Permatector<sup>TM</sup> option. Uncoated galvanized steel exterior is not acceptable
  - 2. Internal assemblies: [22] -gauge, galvanized (G90) steel] except for motor supports which shall be minimum14-gauge galvanized (G90) steel.
- B. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
  - 1. Materials: Rigid urethane injected foam. Foam board not acceptable.
    - a) Thickness: 2 inch (50.8 mm)
    - b) Thermal Resistance: R13
    - c) Thermally broken

- d) Meets UL94HF-1 flame requirements
- e) Location and application: Full coverage of entire exterior to include walls, roof of unit, unit base and doors
- 2. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
  - a) Thickness: 2 inch (50.8 mm)
  - b) Thermal Resistance: R8
  - c) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
  - d) Location and application: Divider panels between outdoor air and return air/exhaust air streams.
- C. Roof Insulation: 2 inch (50.8 mm) fiberglass located above the 1 inch (25.4 mm) foam panel. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18-gauge galvanized G90 steel or painted galvannealed steel.
- D. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and directdrive fan(s). Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor(s) shall be capable of continuous speed modulation and controlled by a VFD.
- E. Evaporator Coil: Evaporator coil shall be (silver) soldered or brazed into the compressed refrigerant system. Coil shall be constructed of copper tubing, permanently bonded to aluminum fins, and enclosed in a galvanized steel frame. If two compressors are used as components of the unit, then the evaporator coil shall be of "interlaced" configuration, permitting independent operation of either compressor without conflict with the other compressor.
- F. Control panel / connections: Rooftop Ventilator units shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections. RTU shall be equipped with a Unit Disconnect Switch.
- G. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded austenitic stainless-steel sheet material and provided with a welded stainless-steel drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.
- H. P trap: If the unit is equipped with a condensate drain pan, contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices.
- I. Reheat Coil with factory installed modulating hot gas reheat valve
- J. Packaged DX System: Unit shall have an integral compressor(s) and evaporator coil located within the weather-tight unit housing. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit. The lead refrigerant compressor shall be inverter hermetic scroll-type. Compressors shall be equipped with liquid line filter drier, expansion valve, manual reset high pressure and low-pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with R-410A refrigerant. Compressors shall be mounted within an insulated access compartment and on a raised cabinet shelf to reduce sound and vibration. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.
- K. Condenser Fans: Fan blades must be constructed of aluminum or a composite material and have a geometry designed and documented to reduce sound and energy when compared to a traditional rectangular blade fan. Traditional rectangular blade fans are not allowed due to

increased noise generated and increase power utilized. Condenser fan motors shall be three phase, external rotor, type 56 frame, open air over and shaft up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Lead condenser fan(s) will have an electronically commutated (EC) motor that will modulate to maintain a head pressure set point. Motors shall be UL Recognized and CSA Certified. Single condenser fan running at max RPM and design static pressure shall not exceed an A-weighted sound power level of 75 db at free inlet/outlet test conditions.]

- L. DX Control and Diagnostics: The DX system shall be controlled by an onboard digital controller (DDC) that indicates both owner-supplied settings and fault conditions that may occur. The DDC shall be programmed to indicate the following faults:
  - 1. Global alarm condition (active when there is at least one alarm)
  - 2. Supply Air Proving alarm
  - 3. Compressor Trip alarm
  - 4. Compressor Locked Out alarm
  - 5. Supply Air Temperature Low Limit alarm
    - a) Sensor #1 Out of Range (outside air temperature)
    - b) Sensor #2 Out of Range (supply air temperature)
    - c) Sensor #3 Out of Range (cold coil leaving air temperature)]
- M. Phase and brownout protection: RTU shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.
- N. Motorized dampers / Outdoor Air, Return Air: AMCA Class 1A certified motorized damper of low leakage type and a leakage rate of 3 CFM/ft<sup>2</sup> @ 1 in. wg. shall be factory installed.
- O. AMCA Class 1A motorized recirculating air damper designed to permit 100% maximum recirculation of return air shall be factory installed.
- P. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed as specified by the A/E.
- Q. Horizontal connections through unit only. Plenum curb for horizontal connections is not acceptable.
- R. Service receptacle: 120 VAC GFCI service outlet shall be factory-provided and installed. Unit contains a 120 VAC transformer to provide power to service outlet.
- S. Hail guards: Protects the condensing coil from damage due to extreme weather conditions such as hail and flying debris.

# 2.4. BLOWER

- A. Blower section construction: direct drive motor and blower shall be assembled on a 14-gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.
- B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
- C. Fan: Direct drive, backwards curved, airfoil plenum fan with aluminum wheel statically and dynamically balanced. Prop or belt-drive fan not acceptable due to low static capabilities.
- D. Blades: Welded aluminum or painted steel blades only.
- E. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency.

# 2.5. MOTORS

A. General: Blower motors greater than 1/2 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single

speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure.

B. Motors shall be 60 cycle, 3 phase 460 volts.

# 2.6 UNIT CONTROLS

- A. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors, or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.
- B. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.
- C. RTU supply fan shall be configured for Duct Static Pressure
- D. Exhaust fan shall be configured for Supply Tracking
- E. Outside Air / Return Air damper control shall be CO2 sensor by factory.
- F. Economizer control shall be temperature / enthalpy
- G. Operating protocol: The DDC shall be factory-programmed for BACnet MSTP
- H. Variable Frequency Drive (VFD) unit shall have factory installed variable frequency drive for modulation of the supply air blower assemblies & exhaust air blower assemblies. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
- I. Room thermostat shall be provided as a shipped loose item. The room thermostat shall have an LCD display to adjust the room temperature set point from within the space. The room thermostat shall average 1temperature sensor and 1 relative humidity sensor.
- J. A web user-interface (web UI) must be available for the manufacturer installed controls. The interface can be accessed via a web browser (when an Ethernet cable is connected to the building network) or to a laptop plugged in directly to the controller. Web UI must have the following features available which allow simple access to the unit, improved startup / commissioning and provide quick troubleshooting capabilities:
  - Graphical overview screen for easy access to current conditions and set point changes
  - All sensor values, set point and control outputs recorded each minute with 1 week of history stored on the controller for simple troubleshooting
  - Refrigeration details screen with compressor status, temperature and pressure readings
  - Access to current alarms and alarm history
  - Service override capabilities to manually change I/O and verify proper operation of the unit

# 2.7 FILTERS

A. Unit shall have permanent 1 inch (25.4 mm) aluminum mesh filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 8 disposable pleated filters shall be provided in the supply final air stream and MERV 8 filters in the exhaust air stream.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
- B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.

# 3.3 CONNECTIONS

- A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
  - 1. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings and specialties.
  - 2. Duct installation and connection requirements are specified in Division 23 of this document.
  - 3. Electrical installation requirements are specified in Division 26 of this document.

# 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

# 3.5 START-UP SERVICE

A. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

# 3.6 DEMONSTRATION AND TRAINING

- A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.
- 3.7 WARRANTY
  - A. Warranty shall be a 1-year factory warranty for parts and labor for the complete unit, and a 5year factory warranty on compressor(s). Warranty shall start 6 months after shipment, or when the unit start-up is performed, whichever is sooner.

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END OF SECTION 237424

# SECTION 237433 – CONDENSING UNIT

# Part 1. PRODUCT(S) - Outdoor Units (Variable Refrigerant Flow Systems)

A. Multi V<sup>™</sup> 5 Heat Recovery and Heat Pump System(s) – (6 to 42 tons nominal) ARUM096BTE5

## B. Product Design

1. LG Multi V 5 heating and cooling system shall be an air cooled system allowing user to configure in the field a heat pump or a heat recovery system consisting of one to three outdoor unit modules, conjoined to make a 6-42 ton single refrigerant circuit.

- a) Heat recovery systems, employing three pipes, shall be connected to Heat recovery (heat recovery) unit(s) and indoor unit(s). Multi-port heat recovery units shall allow simultaneous heating and cooling of individual zone(s) at various capacities as required to satisfy their zone requirements.
- b) Heat pump systems shall require two pipes, simultaneous heating and cooling shall not be supported. The heat recovery system shall consist of three pipes, liquid, suction and hot gas pipes. Heat recovery systems operating at 0°F that cannot deliver single phase superheated refrigerant vapor at a minimum of 162°F while operating in the heating mode shall not be acceptable.

2. All three-phase VRF heat pump and heat recovery outdoor units shall be from the same product development generation. Mixing of outdoor units from different development generations is not acceptable.

C. Operating Conditions

1. Outdoor Unit shall be capable of continuous compressor operation between the following operating ambient air conditions, operation outside of these conditions are possible and may involve non-continuous operations.

- 2. Operating Ambient Air Conditions:
  - a) Cooling: -10°F DB to 122°F DB
  - b) Heating: -22°F WB to 61°F WB
  - c) Cooling Based (ODU reversing valve in cooling position) Synchronous: 14°F DB to 81°F DB (Heat Recovery Operation Only)
  - d) Heating Based (ODU reversing valve in heating position) Synchronous: 14°F WB to 61°F WB (Heat Recovery Operation Only)
- D. Electrical
- e) All air source heat pump and heat recovery frame(s) shall be designed and electrically protected to maintain stable continuous compressor operation when provided with 208-230/60/3 power with the following specifications:

i. <208-230/60/3>

- 1. Voltage fluctuation of ± 10%
  - ii. Voltage imbalance of up to two percent;
  - iii. Power surge of up to 5kA RMS Symmetrical.
- E. General Features
- 1. The air-conditioning system shall use R410A refrigerant.

2. Each system shall consist of one, two or three air source outdoor unit modules conjoined together in the field to result in the capacity specified elsewhere in these documents.

3. Dual and triple frame configurations shall be field piped together using manufacturer's designed and supplied Y-branch kits and field provided interconnecting pipe to form a common refrigerant circuit.

- 4. System shall have following frame configurations vs. capacity.
  - a) 6 to 20 ton units shall be a single frame only.
  - b) 22 to 34 ton units shall be dual frame only.
  - c) 36 to 42 ton heat recovery units shall be triple frame only

5. System shall employ self-diagnostics function to identify any malfunctions and provide type and location of malfunctions via fault alarms.

- 6. Field Provided Refrigerant Piping
  - a) The refrigerant piping system shall be constructed using field provided ACR copper rated for the use with refrigerant R410A, de-hydrated pipe field engineered and assembled with manufacturer supplied Heat recovery unit(s) and Y- branches, as may be required, connected to multiple (ducted, non-ducted or mixed combination) indoor units to effectively and efficiently control the heat pump operation or simultaneous heating and cooling operation of the heat recovery VRF system. Other pipe materials, if used, shall perform, at a minimum, as well as that specified above, shall not have any adverse reactions, for example galvanic corrosion or branch to branch differential pressure drop, with any other components or materials also in use in the system and shall be installed per manufacturer's instructions.
  - b) The unit shall be shipped from the factory fully assembled including internal refrigerant piping, inverter driven compressor(s), controls, temperature sensor, humidity sensor, contacts, relay(s), fans, power and communications wiring as necessary to perform both Heat Pump and Heat Recovery operations.
  - c) Each outdoor unit refrigeration circuit shall include, but not limited to, the following components:
    - i. Refrigerant strainer(s)
    - ii. Check valve(s)

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- iii. Inverter driven, medium pressure vapor injection, high pressure shell compressors
- iv. Liquid refrigerant cooled inverter PCB
- v. Oil separator(s)
- vi. Accumulator /controlled volume receiver(s)
- vii. 4-way reversing valve(s)
  - 1. Vapor injection valve(s)
- viii. Variable path heat exchanger control valve(s)
- ix. Oil balancing control
- x. Oil Level sensor(s)
- xi. Electronic expansion valve(s)
  - 1. Sub-cooler (s)
  - 2. Vapor Injection Valve(s)
- xii. High and low side Schrader valve service ports with caps
  - 1. Service valves
- 7. Field Insulation:
  - a) All refrigerant pipe, y-branches, elbows and valves shall be individually insulated with no air gaps. Insulation heat transfer resistance shall not be less than the minimum called for by the local building code, local energy code or as a minimum per manufacture installation requirements. In no case shall the insulation be installed in a compressed state at any point in the system.
    - i. All joints shall be glued and sealed per insulation manufactures instructions to make a vapor tight assembly.
- 8. Microprocessor:
  - a) Factory installed microprocessor controls in the outdoor unit(s), heat recovery unit(s), and indoor unit(s) shall perform functions to optimize the operation of the VRF system and communicate in a daisy chain configuration between outdoor unit and heat recovery unit(s) and indoor unit(s) via RS485 (shielded twisted wire pair) network. Control devices shall also be available to control other building systems as required from the VRF control system. DIO/AIO capabilities shall be available as well as a central controller to perform operation changes, schedules and other duties as required by this specification. Addition of separate building control system shall not be required. Other control devices and sequences shall be as specified in other sections of this project specification.

- 9. Inverter PCB Cooling:
  - a) Cooling of the inverter PCB shall be conducted by way of high pressure, sub-cooled liquid refrigerant via heat exchanger attached to the inverter PCB. The full capacity flow of refrigerant shall pass though the heat exchangers to maximize the cooling effect of the PCBs and to aid in the evaporation process and capacity of the outdoor coil during the heating mode. The recovered heat of the PCBs must be used to enhance the overall heating process, other uses or dissipation of heat to ambient shall not be permitted.
- 10. Compressor Control:
  - a) Control logic shall establish and maintain target evaporating temperature (Te) in cooling mode and condensing temperature (Tc) in heating mode by Fuzzy control logic to ensure the stable system performance.
- 11. Initial Test Run (ITR) (Heating or Cooling) / Fault Detection Diagnosis (FDD) Code:
  - a) This control mode shall monitor and display positive or negative results of system initial startup and commissioning. Heating or Cooling ITR mode will be automatically selected. It shall monitor and provide performance metrics for the following, but not be limited to, refrigerant charge validation, auto-charge operation verification, refrigerant cycle stability, connection ratios, indoor unit status, error status, and number of indoor units connected. This commissioning specific control mode shall not replace the system error monitoring control system during normal operation.
- 12. BMS Integration:
  - a) The VRF system shall be able to integrate with Building Management Systems via BACnet<sup>™</sup> IP gateway. This gateway converts between BACnet<sup>™</sup> IP or Modbus TCP protocol, and RS-485 LGAP (LG Aircon protocol) allowing third party control and monitoring of the LG A/C system, or LonWorks<sup>™</sup> gateways. See controls specification for points list.
- 13. Wi-Fi Communication:
  - a) The outdoor unit microprocessor shall be capable of being monitored via an optional Wi Fi wireless communications dongle or embedded Wi Fi transmitter. Wi-Fi shall allow service or maintenance personal access to the complete operating system, via LGMV mobile, without need of tools other than smart phone or tablet. Active live system review, collection of all system data for a field determined duration presented in a .csv file format or collection of all operating conditions, including all indoor units, valves, sensors, compressor speeds, refrigerant pressures, etc., by snapshot of conditions and placing that snapshot into a power point slide to be reviewed at another time. Systems that require computers, hard wire only connection or other devices to collect, review or record operating conditions shall not be allowed.
- 14. Indoor Unit Connectivity:
  - a) The system shall be designed to accept connection up to <64> indoor units of various configuration and capacity, depending on the capacity of the system.
- 15. Power and Communication Interruption:

- a) The system shall be capable of performing continuous operation when an individual or several indoor units are being serviced; communication wire cut or power to indoor unit is disconnected from power for a minimum of a 24 hour period. Systems that alarm and/or shut down because of a lack of power to any number of indoor units shall not be acceptable.
- 16. Connection Ratios:
  - a) The maximum allowable system combination ratio for all VRF systems shall be 100% and the minimum combination ratio shall be 50%.
- 17. Comfort Cooling Mode:
  - a) Comfort cooling shall be initiated via a field setting at the outdoor unit during commissioning or anytime thereafter. Comfort cooling shall allow user to select all or some of the indoor units of a system to automatically modify each of the indoor unit's superheat target set point based on the impending total cooling load of on the indoor unit, the rate of change of the zone temperature relative to set point and optionally, if specified, the rate of change of the zone humidity level.

18. The outdoor unit shall be provided with a factory installed fusible plug or rupture disc. The fusible plug connection shall be threaded for easy connection with a field provided vent pipe to safely discharge the system's refrigerant charge away from the outdoor unit if a building fire causes an extreme pressure condition in the outdoor unit refrigerant circuit employ for safety a threaded fusible plug.

- 19. Refrigerant Flow Control
  - a) An active refrigerant -in-circulation control system consisting of a refrigerant storage container, interconnecting refrigerant piping control valves, pressure transducers, microprocessor control, and software to continuously monitor necessary refrigeration cycle operating parameters to maintain stable cycle operation between minus (-)22°F and 122°F ambient conditions. The refrigerant system operating conditions shall be checked by the algorithm at three minute intervals and if needed automatically and dynamically remove and store refrigerant to the storage tank or inject refrigerant from the tank into the refrigerant circuit.
    - i. The algorithm shall adjust refrigerant charge automatically:
      - 1. As the outdoor air temperature changes;
      - 2. System mode of operation changes;
      - 3. The path of refrigerant flow through the outdoor coil is modified;
      - 4. The system's target suction and head pressure control values are adjusted.
  - b) Subcooler: The VRF outdoor unit shall include a factory provided and mounted subcooler assembly consisting of a shell and tube-type sub-cooling heat exchanger and EEV providing refrigerant sub-cooling modulation control by fuzzy logic of EEV and by mode of operation to provide capacity and efficiency as required. Brazed plate heat exchangers shall not be allowed for this function.

- c) Advanced Smart Load Control: The air source unit shall be provided with Smart Load Control (SLC) enhanced energy saving algorithm that reduces compressor lift during off-peak operation to further reduce system energy consumption when weather and load conditions permit.
  - ii. The SLC algorithm shall be monitoring in real time, the rate of change of the outdoor ambient air temperature, either the outdoor ambient air relative humidity or the indoor air relative humidity [field selectable], and the rate of change of the building load.
  - iii. The SLC algorithm shall foresee pending changes in the building load, outdoor temperature and humidity (or indoor humidity) and proactively reset head and/or suction pressure targets in anticipation of the reduction/increase in building load.
  - iv. The SLC algorithm shall provide no fewer than three (3) field selection options to maximize the control of the VRF system operation during morning warm-up or cool-down following night-setback reset. The selection shall be set by the commissioning agent (or at any other time thereafter). Selectable algorithm choices include:
- 2. Maximize energy savings
- 3. Balance the rate of temperature change with energy consumed.
- 4. Quickly cool/heat the building.
- 20. VRF Systems with Onboard Alternate Operating Mode Selection Capability
  - a) All VRF systems equipped with field selectable Alternate Operating Modes via DIP Switch or other means, for example but not limited to, High Heat, High Ambient Cooling, High Sensible, or Enhanced Efficiency selections. Performance using the proposed field selected Alternate Operating Mode shall be tested using AHRI Standard 1230 and published in the AHRI Directory.
  - b) Acceptable Alternate Operating Modes must ship with all models of the VRF product offering and must be factory embedded. Custom factory or field modifications to factory provided algorithms created to meet scheduled requirements are not acceptable.
  - c) Provide a copy of instructions required to set the Alternate Operation Mode with the initial submittal.

d) For systems that provide field selectable Alternate Operating Modes, ALL technical data provided in the submittal data sheets showing product rated condition performance data, must also provide separate data sheets that show product performance data at each of the field selectable Alternate Operating Modes available. Capacity, <u>power input</u>, and acoustic performance data for each mode offered shall be reported separately. Mixing of ODU, IDU, or VRF system performance capability operating in one mode with for example the power consumption, sound power rating, or electrical requirements of the same system operating in another mode is not acceptable.

# F. Defrost Operations

1. The outdoor unit(s) shall be provided with a minimum of 4 independent field adjustable defrost cycle algorithms to maximize the effectiveness of the defrost cycle to the local weather conditions. Intelligent Defrost shall melt accumulated frost, snow and ice from the outdoor unit heat exchanger. The defrost cycle length and sequence shall be based on outdoor ambient temperatures, outdoor unit heat exchanger temperature, and various differential pressure variables. Intelligent Heating Mode, when outdoor unit humidistat is engaged, shall extend the normal heating sequences by adjusting the outdoor unit coil target temperature to be above the ambient dew point temperature delaying the need for defrost operations, so long as heating demand is being met.

2. Smart Heating: This feature shall be capable of eliminating several defrost actions per day based on outdoor air temperature and humidity conditions. Smart heating shall extend the heating operation cycle by delaying the frost formation on the outdoor coil by adjusting the surface temperature to keep it above the current outdoor ambient dew point. The algorithm shall delay while maintaining indoor space temperature.

3. Defrost Mode Selection: The outdoor unit shall be provided with a minimum of three field selectable defrost operation modes: Normal, Fast, or Forced.

- a) Normal Defrost: Operation intended for use in areas of the country that experience adverse winter weather with periods of heavy winter precipitation and extremely low temperatures. This strategy shall maximize the systems heating performance and maintain operational efficiency. When the ambient temperature is either: a) above 32°F or b) below 32°F with the humidity level below 60% RH, Intelligent Defrost shall continue heating regardless of ice build-up on the coil until the quality of the heated air (i.e. discharge air temperature) decreases. At temperatures below 4°F, a defrost cycle shall occur every two hours to optimize system heating efficiency.
- b) Fast Defrost: Operation intended for use in areas of the country with mild winter temperatures and light to moderate humidity levels. The strategy minimizes defrost cycle frequency allowing frozen precipitation to build longer in between cycles. Minimum time between defrost cycles shall be 20 minutes. Intelligent Defrost shall choose between split coil/frame and full system methods based on current weather conditions to minimize energy consumption and maximize heating cycle time.
- c) Forced Defrost: Operation shall be available for the service provider to test defrost operations at any weather condition and to manually clear frozen water from the outdoor coil surfaces.

4. Defrost Method Selection: The outdoor unit shall be provided with two field selectable defrost operation methods: Split Coil/Frame and Full System. Split Coil/Frame option provides continuous heating of the occupied space during defrost operation.

- a) Split Coil/Frame method shall be available when Normal Defrost mode is selected. Split Coil method shall be available on all Heat Pump and Heat recovery single-frame VRF systems. Split Frame defrost shall be available on all Heat Pump and Heat recovery multi-frame outdoor units.
- b) Split Coil method shall remove ice from the bottom half of the outdoor unit coil first for a maximum time of six minutes, then the top half for a maximum of six minutes. Next the bottom coil shall be heated again for an additional three minutes to remove any frozen water that may have dripped onto the lower coil during the top coil defrost operation.
- c) When Split Coil/Frame method is selected, a Full System defrost shall occur every 1-9 (field selectable) defrost cycles to assure 100% of the frozen precipitation has been removed to maintain efficient performance.
- d) Full System method shall be available as a field selectable option. All outdoor units located in areas of the country where large volumes of frozen precipitation are common, the commissioning agent shall be able to select the Full System only defrost method.
- 5. Indoor Unit Fan Operation During Defrost
  - a) During partial defrost operation indoor units operating in cooling or dry mode shall continue normal operation.
  - b) During partial defrost operation, indoor units that are commissioned with fans set for continuous operation shall maintain normal fan speed unless the leaving air temperature drops, then the fan speed will be reduced to low speed for the remainder of the defrost cycle.
  - c) During full system defrost operation indoor unit fans will cycle off and remain off during the remainder of the defrost cycle.
- G. Oil Management

1. The system shall utilize a high pressure oil return system to ensure a consistent film of oil on all moving compressor parts at all points of operation. Oil is returned to compressor through a separate high pressure oil injection pipe directly into the oil sump. Oil returned to the compressor via the suction port of the compressor shall not be allowed.

2. Each compressor shall be provided with a high efficiency independent centrifugal cyclone type oil separator, designed to extract oil from the oil/refrigerant gas stream leaving the compressor.

3. The system shall have an oil level sensor in the compressor to provide direct oil level sensing data to the main controller. The sensor shall provide data to main outdoor unit PCB to start oil return mode and balance oil levels between multiple compressors.

4. The system shall only initiate an oil return cycle if the sensed oil level is below oil level target values as determined by the microprocessor. The system shall display an error if the oil sensor signals low oil level for a period of 130 minutes or longer.

5. A default oil return algorithm shall automatically initiate the oil return mode if the system detects a failure of the oil sump sensor. A fault code shall be reported by the system.

6. Timed oil return operations or systems that do not directly monitor compressor oil level shall not be permitted.

- 7. Indoor Unit Fan Operation during Oil Return Cycle
  - a) During oil return cycle indoor units operating in cooling or dry mode shall continue normal operation.
  - b) During oil return, indoor units that are commissioned with fans set for continuous operation shall maintain normal fan speed unless the leaving air temperature drops, then the fan speed will be reduced to low speed for the remainder of the oil return cycle.
  - c) During oil return cycle indoor unit fans will cycle off and remain off during oil return cycle while operating in all modes.
- H. Fan and Motor Assembly

1. 6 ton frames shall be equipped with one direct drive variable speed propeller fan with Brushless Digitally Controlled (BLDC) motor with a vertical air discharge.

2. 8 to 20 ton frames shall be equipped with two direct drive variable speed propeller fan(s) with BLDC motor(s) with a vertical air discharge.

3. The fan(s) blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material and incorporate biomimetic technology to enhance fan performance and reduce fan generated noise.

4. The fan(s) motor shall be equipped with permanently lubricated bearings.

5. The fan motor shall be variable speed with an operating speed range of 0-1150 RPM cooling mode and 0-1150 RPM heating mode.

6. The fan shall have a guard to help prevent contact with moving parts.

7. The cabinet shall have option to redirect the discharge air direction from vertical to horizontal with the addition of optional factory provided air guides.

8. The fan controller shall have a DIP switch setting to raise external static pressure of the fan up to 0.32 inch of W.C. to accommodate ducted installations.

9. The fan control shall have a function setting to remove excess snow automatically.

10. The fan control shall have a function setting to remove access dust and light debris from the outdoor unit and coil.

I. Cabinet

1. Outdoor unit cabinet shall be made of 20 gauge galvanized steel with a weather and corrosion resistant enamel finish. Outdoor unit cabinet finish shall be tested in accordance with ASTM B-117 salt spray surface scratch test (SST) procedure for a minimum of 1000 hours. 2. Cabinet weights and foot prints shall vary between 430 lbs., 7.61 sq. ft. (1.27 sq. ft. per ton), for 6 ton cabinet to 666 lbs., 10.14 sq. ft. (.51 sq. ft. per ton), for 20 ton cabinet for single cabinet configurations. The front panels of the outdoor units shall be removable type for access to internal components.

3. A smaller service access panel, not larger than 7" x 7" and secured by a maximum of (2) screws, shall be provided to access the following:

- a) Service tool connection
- b) DIP switches
- c) Auto addressing
- d) Error codes
- e) Main microprocessor
- f) Inverter PCB

4. The cabinet shall have piping knockouts to allow refrigerant piping to be connected at the front, right side, or through the bottom of the unit.

- 5. The cabinet shall have a factory installed coil guard.
- J. Outdoor Unit Coil
- 1. Outdoor unit coil shall be designed, built and provided by the VRF outdoor unit manufacturer.

2. The outdoor unit coil for each cabinet shall have lanced aluminum fins with a maximum fin spacing of no more than 17 Fins per Inch (FPI). All the outdoor unit coils shall be a 2 or 3 rows consisting of staggered tubes for efficient air flow across the heat exchanger

3. Outdoor unit coil shall be comprised of aluminum fins mechanically bonded to copper tubing with inner surfaces having a riffling treatment to expand the total surface of the tube interior

4. The aluminum fin heat transfer surfaces shall have factory applied corrosion resistant Black Fin coating. The copper tubes shall have inner riffling to expand the total surface of the tube interior.

- a) ISO 21207 Salt Spray Test Method B 1500 hours
- b) ASTM B-117 Acid Salt Test 900 hours
- c) The Black Fin coating shall be certified by Underwriters Laboratories and per ISO 21207. The above conditions shall establish the minimum allowable performance which all alternates must comply.

5. Variable Path Heat Exchanger: System shall have a variable flow and path outdoor heat exchanger function to vary the refrigerant flow and volume and path. Control of the variable path circuits shall be based on system operating mode and operating conditions as targeted to manage the coil heat transfer capacity and efficiency. The variable path heat exchanger technology shall be provided to maintain stable refrigeration cycle operation during mild weather conditions and maintain a robust hot vapor temperature system head pressure that delivers "gas-furnace leaving air temperature" from the indoor unit at sub-zero outdoor air temperature down to minus (-) 22°F.The outdoor unit coil, all indoor units and pipe network shall be field tested to a minimum pressure of 550 psig.

# K. Compressor(s)

1. Compressor shall be designed and assembled by the VRF manufacturer specifically for use in the air source VRF product line. Third party manufactured, branded, or designed to the VRF system's OEM specifications by a third party manufacturer shall not be acceptable.

2. Compressor shall be a hermetic, high-side shell (HSS), commercial grade, compliant scroll direct-drive design.

a) Compressor Design: The compressor design shall be of the high pressure shell scroll type where the internal pressure below the suction valves of the compressor shall be at the same high pressure and high temperature. The motor shall be cooled by high pressure gas at temperatures above saturation conditions and minimize the mixing of refrigerant liquid with oil in the sump. The system shall employ a high pressure oil return method returning recovered oil from the oil separator directly into the oil sump of the compressor; oil shall not be allowed to return via the suction line. Bearing surfaces are continually coated with oil. The compressor shall employ an Aero-bearing constructed with high lubricity materials increasing operation time in case of low sump oil level. Compressor shall have a nominal operating range from 12Hz to 150 Hz.

3. The fixed and oscillating compressor scroll components shall be made of high grade (GC25) or denser steel material. All scrolls shall be heat treated and tempered.

4. The oscillating scroll shall be finely machined and polished. PVE refrigerant oil shall be used as the sole liquid used to maintain a seal between the high and low sides of the compression chamber. Compressors that requires the use of any type of mechanical or wearable sealant material between the moving surfaces of the compression chamber is NOT ACCEPTABLE.

5. Vapor Injection: System shall have a medium pressure gas vapor injection function employed in the heating and cooling modes to increase system capacity when the outdoor ambient temperatures are low and lower compressor lift when temperatures are high. The compressor vapor injection flow amount shall be controlled by the vapor injection sub-cooling algorithm reset by discharge gas temperatures of the compressor.

6. Bearing surfaces shall be coated with Teflon<sup>®</sup> equal. Bearings shall be lubricated using a constant flow of PVE refrigerant oil to the bearing surfaces The film of oil separating the crankshaft journals and bearing surfaces shall be consistent at all times the crankshaft is in motion and shall be maintained irrelevant of crankshaft rotational speed.

7. An internal, integrated, mechanically driven gear pump shall draw oil from the compressor sump reservoir, pressurize the oil and inject the oil directly to the crankshaft journals maintaining a consistent film of oil between all moving parts. Auxiliary, indirect, or electronically driven pumps are not acceptable.

8. The viscosity property of the PVE oil in the compressor sump shall be maintained irrelevant or compressor operation and the surrounding ambient temperature.

a) The compressor shall be equipped with an external thermally protected electric crankcase heater that is automatically activated only when the ambient temperature is below freezing and the compressor is not running to maintain the temperature of the oil in the sump above the refrigerant boiling point.

- b) During stable operation, irrelevant of ambient air temperature outside the water source unit, the temperature of refrigerant vapor in contact with the surface of the oil in the compressor sump shall be maintained above 140°F to prevent foaming and to eliminate refrigerant from mixing with the oil degrading the viscosity of the oil in the sump.
- c) Low side shell (LSS) type compressors that use suction vapor to cool the compressor motor shall not be acceptable.
- 9. The compressor motor shall be designed to operate at high temperatures.
  - a) The motor winding insulation shall be designed to operate continuously at a minimum temperature of 180°F without deterioration.
  - b) The motor cooling system shall be designed to maintain acceptable operational temperature at all times and in all conditions using high pressure, hot refrigerant vapor as motor coolant.
  - c) Low side shell (LSS) and compressors that use low pressure, low temperature refrigerant gas to cool the motor are not acceptable.
- 10. Inverter Compressor Controller(s)
  - a) Each compressor shall be equipped with a dedicated inverter compressor drive. The control of multiple compressors using a single drive is not acceptable.
  - b) The inverter drive shall vary the speed of the compressor crankshaft between zero (0) Hz and 140 Hz.
  - c) The inverter driver controller shall be matched with the physical properties of the compressor. The drive shall be manufactured by the VRF air source unit manufacturer. The inverter drive and matching compressor shall have been thoroughly tested as a matched pair. The inverter drive shall be programmed to avoid operating the compressor at any speed that results in harmonic vibration, nuisance noise, or mechanical damage to either the driver or the compressor with power provided that is within the tolerance specification.
  - d) The compressor inverter drive assembly and software must be designed, manufactured, and supplied by the VRF product manufacturer. Third party branded inverter driver hardware and/or driver software or inverter driver hardware and/or software provided by a third party manufacturer to meet OEM specifications of the VRF water source manufacturer will not acceptable.
  - e) All inverter drive hardware or software manufactured in, is a product of, or sourced from China, or using a broker or third party provider as an intermediary that obtains the product from CHINA shall not be acceptable.
- 11. Compressor(s)
  - a) Each 6, 8, 10 ton frames shall be equipped with a single hermetically sealed, inverter driven, High Side Shell (HSS) scroll compressor.

- b) 12, 14, 16, 18 and 20 ton frames shall be equipped with dual hermetically sealed, inverter driven, High Side Shell (HSS) scroll compressors.
- c) Each inverter driven, HSS scroll compressor shall be capable of operating from 12 Hz up to 150 Hz in any and all modes (cooling, heating or simultaneous modes).
- d) The compressor shall be designed for a separate port for oil to be directly returned to the compressor oil sump.
- e) The compressor bearing(s) shall have Teflon<sup>™</sup> coating and shall be an aero type design using High lubricity materials.
- f) The compressor(s) shall be protected with:
  - i. High Pressure switch
  - ii. Over-current /under current protection
  - iii. Oil sump sensor
  - iv. Phase failure
  - v. Phase reversal
  - vi. Compressor shall be capable of receiving injection of medium pressure gas at a point in the compression cycle where such injection shall allow a greater mass flow of refrigerant at lower outdoor ambient and achieving a higher heating capability. The VRF outdoor unit shall have published performance data for heating mode operation down to -22°F on both heat pump and heat recovery systems.
- g) Standard, non-inverter driven compressors shall not be permitted nor shall a compressor without vapor injection or direct sump oil return capabilities.
- L. Operational Sound Levels

1. The compressor(s) shall be mounted on rubber isolation grommets. Compressor shall ship with removable clamps that secure the compressor in place while transported. The installing contractor shall remove and discard (or optionally adjust the clamps to allow the isolator to properly function) the clamps prior to commissioning the water source unit.

2. Each single frame outdoor unit shall be rated with an operational sound pressure level not to exceed as listed on below chart when tested in an anechoic chamber under ISO 3745 standard at the highest field selectable heating operating modes available. Such documentation shall be presented in all submittals, manufactures who elect to rate their equipment at other than tested in an anechoic chamber under ISO 3745 standard at the highest field selectable and the highest field selectable conditions shall not be allowed.

3. A field setting shall be available to program the outdoor unit to reduce sound levels at night, when desired, to a selectable level while still able to meet building load requirement. This mode is available in both cooling and heating modes.

- M. Sensors
- 1. Each outdoor unit module shall have:
  - a) Suction temperature sensor
  - b) Discharge temperature sensor
  - c) Oil level sensor
  - d) High Pressure sensor
  - e) Low Pressure sensor
  - f) Outdoor temperature sensor
  - g) Outdoor humidity sensor
  - h) Outdoor unit heat exchanger temperature sensors
- N. Wind Load Installations for Outdoor Units

1. Provide Florida wind Load Installation Drawings that meet the requirements of the 2017 Florida Building Code, 6th Edition and ASCE Standard 7-2010 with submittal.

O. Seismic Installations

1. Provide with submittal: 1) OSHPD Special Seismic Certification Preapproval (OSP) documents for certified product list of VRF equipment to be installed in high seismic risk areas. 2) Equipment installation documents in conformance with CBC 2013, 2016 and 2019 California Building Code and IBC 2012, 2015 and 2018 International Building Code.

- P. Warranty
- 1. Limited Warranty Period
  - a) STANDARD ONE-YEAR PARTS WARRANTY FOR A QUALIFIED SYSTEM The Part(s) of a qualified System, including the compressor, are warranted for a period (the "Standard Parts Warranty Period") ending on the earlier to occur of one (1) year after the date of original installation, or eighteen (18) months from the date of manufacture.
- Q. Training

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, & maintain the entire unit. Training to occur at Substantial Completion.

## END OF SECTION 237433

# SECTION 238126 – DUCTLESS SPLIT-SYSTEM HEAT PUMP UNITS

# Part 1. PRODUCT(S) – Outdoor Units (Single Zone Systems- Cassette/Ducted/VAHU)

# 1.01 Single Zone with LGRED° Heat Pump Outdoor Unit (Cassette/Ducted/VAHU) LUU240HHV

#### A. Operating Conditions

- 1. The outdoor unit shall be capable of the following ambient operating range.
  - i. Cooling: -10°F DB to 118°F DB
  - ii. Heating: -13°F WB to 64°F WB

#### **B.General**

- 1. Unit shall be manufactured by LG.
- 2. The air-conditioning system shall use R410A refrigerant.
- 3. Each system shall have one air source outdoor unit.

4. The refrigerant circuit shall be field piped to a single matching indoor unit to effectively and efficiently control the heating or cooling operation of the system.

5. All refrigerant piping from outdoor unit to indoor unit shall be field insulated.

6. Factory installed microprocessor controls in the outdoor unit and indoor unit shall perform functions to efficiently operate the single zone system and communicate via minimum 14 AWG, 4 conductor, stranded, shielded or unshielded power/communication cable. If shielded, it must be grounded to chassis at ODU only.

7. The outdoor unit shall be internally assembled, wired and piped from the factory.

8. The factory assembled system shall have the outdoor unit fitted with refrigerant strainer, check valves, oil separator, accumulator, 4-way reversing valve, electronic expansion valve, high side and low side refrigerant charging ports, and a service port.

a)The outdoor unit shall include a sub cooler, vapor injection valve and vapor bypass circuit.

C.Piping capabilities

- 1. The outdoor unit shall be capable of operating at an elevation of 98.4 feet above or below the indoor unit.
  - 2. The outdoor unit shall be capable of operating with up to 164 feet or 246 feet of total equivalent refrigerant piping length.
  - D. Defrost Operations
- 1. The outdoor unit shall be capable of auto defrost operation to melt accumulated ice off the outdoor unit heat exchanger. The defrost cycle control shall be based on outdoor ambient temperatures and outdoor unit heat exchanger temperatures.

2. Factory installed base pan heater shall be included for outdoor units.

E.Oil Management

1. The outdoor unit shall have an oil injection mechanism to ensure a consistent film of oil on all moving compressor parts at low speed.

2. The outdoor unit shall have an oil separator to separate oil mixed with the refrigerant gas during compression and return oil to the compressor.

F. Cabinet

1. The outdoor unit cabinet shall be made of pre-coated metal (PCM).

2. The front/side panels of the outdoor unit shall be removable type for access to internal components.

- 3. Outdoor unit cabinet shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.
- G. Fan Assembly
- 1. Each 1-1/2 to 2 ton outdoor unit shall be equipped with one direct drive variable speed propeller fan with Brushless Digitally Controlled (BLDC) motor with a horizontal air discharge.
  - 2. The fan blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material.
  - 3. The fan(s) shall be equipped with permanently lubricated bearings.
  - 4. The fan motor(s) shall have variable speed to a maximum of 800 RPM.
  - 5. The fan(s) shall have a raised guard to help prevent contact with moving parts.
  - H. Outdoor Coil
- 1. Variable Path Heat Exchanger
  - a) System LUU240HHV shall have a variable flow path and outdoor heat exchanger function to vary the refrigerant flow volume and path. Control of the variable path circuits shall be based on system operating mode and operating conditions as targeted to manage the coil heat transfer capacity and efficiency.
  - b) The variable path heat exchanger technology shall be provided to maintain stable refrigeration cycle operation during mild weather conditions and maintain a robust hot vapor temperature system head pressure that delivers "gas-furnace leaving air temperature" from the indoor unit at sub-zero outdoor air temperature down to minus (-) 13°F.

2. The aluminum fins shall have factory applied corrosion resistant GoldFin<sup>™</sup> material.

3. Coil coating shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 1000 hours.

- 4. The outdoor unit coil shall be factory tested to a pressure of 600 psig.
- 5. The coil for each outdoor unit shall have a minimum of 14 Fins per Inch (FPI).
- 6. The coil for each outdoor unit shall have a 2 row heat exchanger.

- 7. The outdoor unit cabinet shall have a coil guard.
- I. Compressor
- 1. The outdoor unit shall be equipped with one hermetically sealed, digitally controlled, inverter driven R1 scroll compressor.

2. The inverter driven, digitally controlled compressor shall be capable of operating in a frequency range from 10 Hz to 95 Hz (cooling), 10Hz to 130Hz (heating) with control in 1 Hz increments.

3. The outdoor unit shall have a medium pressure gas vapor injection function employed in the heating and cooling modes to increase system capacity when the outdoor ambient temperatures are low and lower compressor lift when temperatures are high. The compressor vapor injection flow amount shall be controlled by the vapor injection sub-cooling algorithm reset by discharge gas temperatures of the compressor.

- 4. The compressor shall be mounted on vibration attenuating rubber grommets.
- 5. The compressor shall use a factory charge of Polyvinyl Ether (PVE) oil.
- 6. The compressor bearing(s) shall have Teflon<sup>™</sup> coating.
- 7. The compressor shall be equipped with over-current protection.
- 8. Standard, non-inverter driven compressors shall not be permitted nor shall a compressor without vapor injection or direct sump oil return capabilities.
- J. Sound Levels
- 1. The outdoor unit shall have sound levels not exceeding 56 dB(A) tested in an anechoic chamber under ISO 3745 standard.

2. A field setting shall be available to program the outdoor unit to reduce sound levels at night, when desired, to a selectable level while still able to meet building load requirement. This mode is available in both cooling and heating modes.

# K.Sensors

1. The outdoor unit shall have

a)Suction temperature sensor

b) Discharge temperature sensor

c) High pressure sensor

- d) Low Pressure sensor
- e)Outdoor temperature sensor

f) Outdoor unit heat exchanger temperature sensor

- g)Vapor injection inlet temperature sensor
- h) Vapor injection outlet temperature sensor

L. Wind Load Installations for Outdoor Units

- 1. Provide Florida wind Load Installation Drawings that meet the requirements of the 2017 Florida Building Code, 6th Edition and ASCE Standard 7-2010 with submittal.
  - M. Warranty
- 1. Limited Warranty Period
  - a)STANDARD FIVE (5) YEAR WARRANTY FOR A QUALIFIED SYSTEM The Part(s) of a qualified System, including the compressor, are warranted for a period (the "Standard Parts Warranty Period") ending five (5) years after the date of original installation. In absence of proof of installation the warranty date will end five (5) years from the date of manufacture.
  - N. Training

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, & maintain the entire unit. Training to occur at Substantial Completion.

END OF SECTION 238126

# SECTION 260010 – GENERAL REQUIREMENTS

PART 1 - GENERAL

# 1.1 CONDITIONS

A. The General Conditions, Supplementary General Conditions and Division 1 General Requirements apply to Division 26.

## 1.2 SUMMARY OF WORK

- A. The work to be done under this Specification and the accompanying drawings includes the furnishing of labor, materials, equipment and services necessary for the proper completion of plumbing work
- B. The omission of express reference to any parts necessary for or reasonably incidental to a complete installation shall not be construed as releasing the contractor from furnishing such parts.
- C. All work shall be performed in a clean and workmanlike manner. Care shall be exercised to minimize any inconvenience or disturbance to other areas of the building which are to remain in operation. Isolate work areas by means of temporary partitions and/or tarps to keep dust and dirt with construction area.
- D. No equipment, etc. shall be removed, disconnected, or shut down without prior review with the Owner and/or Engineer to confirm that areas to remain in operation will not be affected. If any areas not within the scope of work are affected by any shutdown, removal, or disconnection, sufficient advance notice must be given to the Owner indicating which areas will be affected, when the proposed shutdown will occur, and for how long a period of time.
- E. All items indicated to be demolished or removed shall become property of the contractor and shall be disposed of off-site unless indicated otherwise.
- F. Contractor shall field verify all dimensions and existing conditions prior to proceeding with any work. Where discrepancies occur between these documents and existing conditions, the discrepancy shall be reported to the Owner and/or Engineer for expediting and resolution.
- G. Clean the job site daily and remove from the premises any dirt and debris caused by the performance of the work included in this contract.
- H. Use of the Owner's elevators and building corridors for handling of the removed equipment and materials shall be at the direction of the Owner and shall be coordinated with his operations.
- I. The Contractor shall be responsible for the safekeeping of his own property on the job site. Owner assumes no responsibility for protection of properties against fire, theft, and environmental conditions.
- J. Where used, the term "Provide" shall mean "Furnish and Install."

- K. The Contractor shall coordinate his work with all other trades.
- L. Contractor to provide for final connections to equipment, including Owner-provided equipment.

# 1.3 INSPECTION OF SITE

- A. Before submitting a proposal on the work contemplated in this Specification and accompanying drawings, each bidder shall examine the site and check as to the means of making connections to services and shall familiarize himself with the existing conditions and limitations. No extras will be allowed because of the contractor's misunderstanding as to the amount of work involved or lack of knowledge of any site conditions which may affect the work. Any apparent variance of the plan or specification from the existing conditions at the site shall be called to the attention of the Engineer during the bid period so clarification can be made by addendum.
- B. The existence of any wires, conduits, pipes, ducts, or other facilities are shown in a general way only. It will be the duty of the bidding contractors to visit the site and make exact determination of the existence of such facilities prior to the submission of bids. It is understood that the bidders will be responsible for making the exact determination of the location and condition of such facilities.

# 1.4 FEES, PERMITS, TAXES, AND INSPECTIONS

- A. Regular inspections shall be requested by the contractor as required by regulations. Charges for the inspections by regulating agencies of installations or plans and specifications shall be paid by the contractor.
- B. All permits, inspections and licenses shall be secured and paid for before actual work is started.
- C. The contractor, after completion of work, shall furnish to the Owner a Certificate of Final Inspection and approval from the inspection bureau having jurisdiction.
- D. State and Local Sales Tax. The Electrical Contractor shall include all state and local sales tax in the bid. The contractor shall maintain accurate records of all taxes and furnish such records to the Owner upon request.

# 1.5 CODES AND STANDARDS

- A. Contractor shall comply with all current ordinances, laws, regulations and codes applicable to the work involved. This does not relieve the contractor from furnishing and installing work shown or specified which may be beyond the requirement of such ordinances, laws, regulations and codes.
- B. In case of difference between building codes, specifications, state laws, local ordinances, industry standards, and utility company regulations and the Contract Documents, the most stringent shall govern. The contractor shall promptly notify the Engineer in writing of such difference.

- C. Non-Compliance: Should the contractor perform any work that does not comply with the requirements of the applicable building codes, state laws, local ordinances, industry standards and utility company regulations, he shall bear all costs arising in correcting the deficiencies.
- D. Contractor shall initiate, maintain, and supervise all safety pre-cautions required for his work including regulations of the Occupational Safety and Health Administration (OSHA).
- E. UL Compliance. All equipment and systems specified in Division 26 shall comply with all applicable UL safety standards and have all required UL listings. All systems shall have UL-listed components, as well as a UL listing for the entire system. When a UL listing for the system is not available, the system shall be tested by an independent laboratory or certified by an impartial licensed professional engineer per Indiana Statutes.

# 1.6 DRAWINGS

- A. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed.
- B. The drawings are to scale as noted but the contractor shall refer to Architectural and structural Drawings for exact location of partitions, walls, beams, shafts, equipment, etc.
- C. Each trade shall avail himself of drawings and specifications of all other trades and make an effort to coordinate his work with all other trades.
- D. The contractor, before roughing-in facilities or installation of any equipment, shall consult all drawings, architectural, structural, mechanical, etc. for finishes, locations of ceiling, ceiling types, structural members, pipes, ducts, recessed lighting fixtures, conduits, etc., which may affect the installation. The contractor in installing his equipment shall leave adequate room for the installation of equipment by other contractors or subcontractors where space is limited.
  - 1. Consideration has been given to such condition of limited space in the preparation of the drawings and the locations and dimensions of equipment have been selected accordingly. The contractor shall be warned that in certain instances, space may be limited to the extent that there may be only one arrangement of equipment or facilities which will allow installation of same.
  - 2. Where connections are made to equipment furnished by others the contractor shall obtain exact location of connection from persons furnishing that equipment. The contractor shall confirm all voltage, circuit breaker, and wiring requirements prior to installation.
- E. Discrepancies discovered before or after work has started, shall be brought to the attention of the Engineer immediately and the Engineer reserves the right to require minor changes in the work to eliminate such discrepancies with no change in contract cost.
- F. The plans and specifications are complementary and what is called for in either one shall be as binding as if called for in both.
- G. Where a disagreement exists in the plans and specifications, the item or arrangement of better quality, greater quantity or higher cost, shall be included.

## 1.7 CAD DRAWING FILES

- A. All Division 26 electronic CAD drawing files provided by the Architect/Engineer for this project are for use solely with respect to this project. The Electrical Contractor may request copies of the Division 26 CAD drawing files for the preparation of shop drawings. However, CAD drawing files shall not be used on other projects, for additions to this project, or for completion of this project by others. Any intentional or unintentional revisions, additions, or deletions to these Division 26 CAD drawing files shall be made at eh full risk of the person(s) making such revisions, additions, or deletions, and such person(s) shall hold harmless and indemnify Architect/Engineer of any and all responsibilities and liabilities.
- B. The CAD files are not to be construed as updated as-built construction documents. The drawing files reflect only bidding documentation of original Construction Drawings. Addenda or written changes occurring during the construction process will not be incorporated into the Division 26 CAD drawing files.
- C. CAD files will be furnished to the Electrical Contractor at the sole discretion of the Engineer.

## 1.8 SYMBOLS AND ABBREVIATIONS

A. Refer to Symbols and Abbreviations listed on drawings. Other symbols are in common usage but if uncertainty exists regarding plan symbols or abbreviations they shall be brought to the attention of the Engineer for clarification.

## 1.9 PRIOR APPROVALS

A. Refer to Section 01 60 00 - Product Requirements for submittal procedures of equivalent products.

#### 1.10 COORDINATION

- A. Coordinate work with other trades in the installation of equipment, piping, conduit, and ductwork.
- B. Refer to Section 01 31 00 Project Management and Coordination for requirements.
- C. Contractors shall solve all coordination conflicts among themselves when possible. The Engineer will arbitrate when necessary, and his judgment will stand, with no additional cost to the owner.
- D. For equipment requiring connections by other contractors, provide Architect approved submittals to the appropriate contractors. Approved submittals are to depict the required connections.
- E. All shop drawings shall be sent to all appropriate contractors for coordination prior to fabrication.

# 1.11 TEMPORARY SERVICES

A. The Electrical Contractor shall carefully examine all parts of the General Requirements for requirements regarding temporary heat, temporary light, and other services. Contractor shall include in his bid an amount to cover his portion of such services.

# 1.12 INSTALLATION METHODS

- A. The methods used for installation for electrical system and equipment shall conform to the National Electrical Contractors Association (NECA) published "Standard of Installation" except where specifically specified or shown otherwise.
- B. Care shall be taken to rough-in outlet boxes, cabinets, etc., to provide a pleasing appearance. Center lines of outlets are to be aligned vertically or horizontally. Where outlets occur in wood panels, below windows, between doors and other such conditions of architectural features, the outlets shall be centered or otherwise located symmetrical with the major feature.
- C. Panelboard and terminal cabinets where located adjacent to each other or one another, shall be same size and tops and bottoms shall be aligned.

# PART 2 - PRODUCTS

## 2.1 FIRE BARRIER SEALING SYSTEM

A. This contractor shall furnish all labor and materials needed to preserve the fire, smoke, and water containment integrity of the fire rated floors, walls and ceilings penetrated by electrical cables, raceway and ducts. Refer to Section 07 84 13 - Penetration Firestopping.

#### 2.2 SPARE PARTS

A. Provide products, spare parts, and maintenance materials as specified in other sections of the Project Manual. Refer to Division 1.

## PART 3 - EXECUTION

# 3.1 CUTTING AND PATCHING

A. This contractor shall perform all cutting and patching necessary in order to perform this work [unless noted on drawings to be performed by the General Contractor]; however, special permission shall be obtained from the engineer before cutting structural members or finished material. Patching shall be performed in such a manner as to leave no visible trace and to return the part affected to the condition of undisturbed work. Patching work shall be performed by workers experienced, skilled, and licensed for the particular type of work involved. Inferior work will not be accepted. Holes in masonry shall be drilled in rotary drills. Impact tools shall not be used.

B. Prevent the spread of dust, debris and other material into adjacent areas.

# 3.2 DEMOLITION

A. Disconnect and remove items noted and as directed. Each Contractor is responsible to remove all equipment, materials, and accessories associated with removed items (insulation, hanger, etc.) under his Contract under the provisions of Division 0.

# 3.3 HOLES THROUGH MASONRY

- A. The Electrical Contractor shall provide all holes and openings required for electrical work.
- B. Holes made in existing masonry for electrical equipment shall be core drilled.
- C. The contractor shall be responsible for grouting air-tight any openings adjacent to raceways etc. to seal against passage of air, smoke or vapors. Maintain ratings of fire rated partitions.
- D. The contractor shall be responsible for providing and disposing of water used in the core drilling operation. Work shall be scheduled and other trades coordinated so that damage will not result from the use of water.
- E. The contractor shall install in each wall and floor sleeve opening fire rated material to maintain the fire rating of partition or floor.
- F. Contractor shall maintain watertight construction.

#### 3.4 FOUNDATIONS AND ANCHOR BOLTS

- A. Install all electrical and motor-driven equipment and associated accessories on 4" high reinforced concrete foundations, unless otherwise specified or noted on Drawings. Extend foundation to support vibration isolation equipment where required.
- B. Foundation to be provided and installed by the General Contractor under provisions of Section 03 30 00.
- C. Provide General Contractor with exact location and dimensions of foundations.
- D. Where the equipment to be installed requires anchor bolts, bolts shall be set to template as the foundations are formed.
- E. 45-degree chamfer corners and edges of foundations by moldings placed in the forms.
- F. Smooth exposed portions of foundations which are rough after removing forms with a mixture of one part cement to two parts sand.

## 3.5 WALL CHASES AND RECESSES

- A. Supervise the construction of chases and recesses in walls for plumbing systems.
- B. Provide the necessary information for the proper size and location to the Masonry Contractor in a timely manner.

#### 3.6 CONCRETE BASES AND PADS

A. Concrete bases and pads for electrical equipment shall be provided by the electrical contractor. Provide concrete pads for all floor mounted and exterior grade mounted electrical equipment.

## 3.7 CHANGING OUTLETS

A. When necessary to fit and center with tile, plaster, paneling and other coverings of the wall, floor or ceiling space, shift the equipment, pipe, or other outlet, as directed by the Architect/Engineer.

## 3.8 RECORD DRAWING NOTES

- A. Contractor shall clearly mark up a set of prints in red to show installed equipment, material and conditions that vary from the original. A complete set of drawings shall be kept at job site at all times upon which each field change shall be marked including all depths, dimensioned locations, sizes, etc. See Division 1.
- B. As work progresses, the contractor shall record all changes and deviations from the Contract Drawings. Refer to Division 1 for specific requirements. Include the following as a minimum:
  - 1. Record exact location and elevation of underground conduits, duct banks and direct burial wiring.
  - 2. Prepare Record Drawing changes for all plumbing work within the building that occurs during the progress of construction. Include such changes as:
    - a. Addenda
    - b. Change orders
    - c. Relocation of devices during construction
    - d. Routing of piping.
    - e. Final locations of equipment.
    - f. Value engineering.
- C. The Record Drawings shall be maintained at the job site and be subject to review by the owner or architect/engineer during the construction period. This record keeping requirement shall not be construed as authorization for the contractor to make changes in the layout without definite instructions by the architect/engineer in each case.
- D. Upon completion of the job, submit scan copy of Project Record Drawings.

# 3.9 OPERATING AND MAINTENANCE MANUAL(S)

- A. Refer to Section 01 78 23 Operation and Maintenance Data for general requirements.
- B. Cross out or delete all information shown on Shop Drawings and other literature definitely not applying to this particular project and its equipment installed.
- C. Manuals that do not meet the foregoing criteria will be rejected and returned to the contractor for resubmittal.

# 3.10 FINAL OBSERVATION

C. A final observation of the electrical systems by the Architect/Engineer will be conducted before the contract can be considered complete. The contractor shall inform the Engineer in writing when the electrical installation is complete and ready for final observation. The Engineer shall visit the project and provide a list of items that need to be corrected or completed to achieve final completion. Should the Engineer attend the project to conduct the final observation and discovers that the work is not sufficiently complete to perform this task, then the contractor shall compensate the Engineer for his time. The contractor shall remain responsible for completing his work and requesting the Engineer to return for a final observation.

## 3.11 TESTS

- A. The contractor shall test the equipment installed under this specification and shall demonstrate its proper operation to the engineer when requested by the engineer.
- B. No equipment shall be tested, or operated for any purpose until it has been fully prepared, connected and made ready for normal operation. Damage to equipment occasioned by improper or ill-timed operation or testing shall be made good, at the contractor's expense, before final inspection and acceptance.

# 3.12 TRAINING

A. Refer to Section 01 79 00 - Demonstration and Training for general requirements.

#### 3.13 MATERIAL AND WORKMANSHIP

A. All material and workmanship must be of the best throughout. Material and equipment must be new and must be adequately protected from damage and dirt. Each item or system shall be listed, inspected, and approved by a nationally recognized testing laboratory and shall bear a label indicating such. The Engineer reserves the right to reject material or workmanship not in accordance with the Specifications, either before or after installation. Contractor will be held responsible for defects in the material and workmanship which may appear during guarantee period after the building has been accepted. Such defects must be repaired or defective material replaced by the contractor at no expense to the owner. Exposed equipment, conduit, plates, panels, cabinets, etc. shall be installed square and true with building construction.
- B. No asbestos, hazardous, or PCB containing materials of any type shall be used on this project.
- C. The contractor shall be responsible for the proper installation of all systems in this contract and shall guarantee to remedy free of charge any defects in workmanship and materials for a period of 12 months from substantial completion.

### 3.14 FIRE RATED CEILINGS

- A. Lighting fixtures and devices which are recessed in fire rated ceilings shall be installed in fire rated enclosures. The Electrical Contractor shall properly locate outlet boxes in the enclosures and shall furnish all necessary equipment dimensions and mounting details as requested by the General Contractor.
- B. All enclosures shall be of sufficient size and depth to permit proper mounting and operation of equipment. Verify requirements with equipment manufacturer.
- C. All lighting fixtures installed in fire rated ceilings shall carry the same UL fire rating as the ceiling.
- D. Refer to Architectural drawings for locations of fire rated ceilings.

# 3.15 FINAL NAMES AND NUMBERS FOR ROOMS AND DOORS

A. Contractor shall note that names and numbers of rooms and doors on the architectural plans may not be the same as that selected by the owner for use in their final naming and/or numbering scheme. Contractor shall use final room names and numbering system as directed by the owner. This shall apply to all labeling, identification, and programming that is required by the Division 26 drawings and specifications.

END OF SECTION 260010

# SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

# PART 1 - GENERAL

## 1.1 SECTION REQUIREMENTS

- A. Submittals:
  - 1. Product Data: For sleeve seals.
  - 2. Shop Drawings: For seismic restraints, signed and sealed by a qualified professional engineer.
    - a. Design analysis to support selection and arrangement of seismic restraints.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: E.
  - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
    - a. Component Importance Factor: To be determined from ASCE 07-10, Section 13.1.1 for each component type.
    - b. Component Response Modification Factor: To be determined from ASCE 07-10, Table 13.6-1 for each component type.
    - c. Component Amplification Factor: To be determined from ASCE 07-10, Table 13.6-1 for each component type.
  - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): S\_DS = 0.437g (43.7%).
  - 4. Design Spectral Response Acceleration at 1-Second Period:  $S_D1 = 0.233g (23.3\%)$ .
- 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 NFPA 70.

## 2.2 RACEWAYS

- A. Raceways:
  - 1. EMT: ANSI C80.3 and UL 797.
  - 2. ENT: NEMA TC 13 and UL 1653.
  - 3. FMC: UL 1; zinc-coated steel.
  - 4. IMC: ANSI C80.6, zinc-coated steel, with threaded fittings.
  - 5. GRC: ANSI C80.1 and UL 6, hot-dip galvanized.

- 6. LFMC: UL 360, zinc-coated, flexible steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
- 7. RNC: UL 621 and NEMA TC 2, Type EPC-40-PVC, with NEMA TC3 fittings.
- 8. Raceway Fittings: Specifically designed for raceway type used in Project.
- B. Wireways: Sheet metal sized and shaped, with screw covers.
- C. Surface Raceways:
  - 1. Metal: Galvanized steel with snap-on covers. Prime coating, ready for field painting.
  - 2. Plastic: PVC, extruded and fabricated to size and shape indicated in color selected, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Floor Boxes: Cast metal, fully adjustable, rectangular.
- E. Handholes and Boxes for Exterior Underground Wiring:
  - 1. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
  - 2. Comply with SCTE 77.
  - 3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
  - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 6. Cover Legend: Molded lettering, "ELECTRIC."

## 2.3 CONDUCTORS AND CABLES

- A. Conductors:
  - 1. Comply with NEMA WC70.
  - 2. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
  - 3. Conductors, Larger Than No. 10 AWG: Stranded copper.
  - 4. Insulation: Thermoplastic, Type THHN-THWN or XHHW.
  - 5. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

## 2.4 GROUNDING MATERIALS

- A. Conductors: Solid for No. 8 AWG and smaller, and stranded for No. 6 AWG and larger unless otherwise indicated.
  - 1. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
  - 2. Bare, Solid-Copper Conductors: Comply with ASTM B 3.
  - 3. Bare, Stranded-Copper Conductors: Comply with ASTM B 8.
- B. Ground Rods: Copper-clad steel, sectional type; 5/8 by 96 inches in diameter.

- C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts with clamp-type pipe connectors sized for pipe.
- D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

# 2.5 ELECTRICAL IDENTIFICATION MATERIALS

- A. Raceway Identification Materials: Self-adhesive, color-coding vinyl tape; flexible, preprinted, self-adhesive vinyl.
- B. Conductor Identification Materials: Color-Coding Conductor Tape: Self-adhesive vinyl tape 1 to 2 inches wide.
- C. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, polyethylene tape with continuous metallic strip or core.
- D. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with circuit identification legend machine printed by thermal transfer or equivalent process.
- E. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- F. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, celluloseacetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
- G. Equipment Identification Labels: Engraved, laminated acrylic or melamine label; punched or drilled for screw mounting. White letters on a dark-gray background; red letters for emergency systems.
- H. Fasteners: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## 2.6 SUPPORT AND ANCHORAGE COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly, and provide finish suitable for the environment in which installed.
  - 1. Channel Dimensions: Selected for structural loading and applicable seismic forces.
- B. Raceway and Cable Supports: As described in NECA 1.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and fittings.
- D. Mounting, Anchoring, and Attachment Components:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud.

#### COMMON WORK RESULTS FOR ELECTRICAL

- 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete.
- 3. Concrete Inserts: Steel or malleable-iron, slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
- 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
- 5. Through Bolts: Structural type, hex head, high strength; complying with ASTM A 325.
- 6. Toggle Bolts: All-steel springhead type.
- 7. Hanger Rods: Threaded steel.

# 2.7 SEISMIC-RESTRAINT COMPONENTS

- A. Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least four times the maximum seismic forces to which they will be subjected.
- B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.
- C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.
  - 1. Seismic Mountings, Anchors, and Attachments: Devices as specified in "Support and Anchorage Components" Article, selected to resist seismic forces.
  - 2. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
  - 3. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
  - 4. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

# 2.8 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized-steel sheet.
- D. Sleeve Seals: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

- 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
- 2. Pressure Plates: Stainless steel. Include two for each sealing element.
- 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

# 2.9 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining.

## PART 3 - EXECUTION

## 3.1 GENERAL ELECTRICAL EQUIPMENT INSTALLATION REQUIREMENTS

- A. Install electrical equipment to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
- B. Install electrical equipment to provide for ease of disconnecting the equipment with minimum interference to other installations.
- C. Install electrical equipment to allow right of way for piping and conduit installed at required slope.
- D. Install electrical equipment to ensure that connecting raceways, cables, wireways, cable trays, and busways are clear of obstructions and of the working and access space of other equipment.
- E. Install required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Comply with requirements in Section 083113 "Access Doors and Frames."
- G. Install sleeve and sleeve seals of type and number required for sealing electrical service penetrations of exterior walls.
- H. Comply with NECA 1.

### 3.2 RACEWAY AND CABLE INSTALLATION

- A. Outdoor Raceways Applications:
  - 1. Exposed or Concealed: IMC.
  - 2. Underground, Single Run: RNC.
  - 3. Connection to Vibrating Equipment: LFMC.
  - 4. Boxes and Enclosures: Metallic, NEMA 250, Type 3R or Type 4.

- B. Indoor Raceways Applications:
  - 1. Exposed or Concealed: EMT.
  - 2. Connection to Vibrating Equipment: FMC; in wet or damp locations, use LFMC.
  - 3. Damp or Wet Locations: IMC.
  - 4. Boxes and Enclosures: Metallic, NEMA 250, Type 1, unless otherwise indicated.
- C. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
- D. Install raceways and cables at least 6 inches away from parallel runs of flues and steam or hotwater pipes. Locate horizontal raceway runs above water and steam piping.
- E. Install raceways embedded in slabs in middle third of slab thickness where practical, and leave at least 1-inch-thick concrete cover.
  - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  - 2. Space raceways laterally to prevent voids in concrete.
  - 3. Install conduit larger than 1-inch trade size, parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.
  - 4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
- F. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- G. Install pull wires in empty raceways.
- H. Connect motors and equipment subject to vibration, noise transmission, or movement with a 72-inch maximum length of flexible conduit.
- I. Install raceways and cables conceal within finished walls, ceilings, and floors unless otherwise indicated.
- J. Install raceways and cables at least 6 inches away from parallel runs of flues and steam or hotwater pipes. Locate horizontal raceway runs above water and steam piping.
- K. Installation of Hangers and Supports:
  - 1. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in this article.
  - 2. Separate dissimilar metals and metal products from contact with wood or cementitious materials, by painting each metal surface in area of contact with a bituminous coating or by other permanent separation.

- 3. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- 4. Multiple Raceways or Cables: Install on trapeze-type supports fabricated with steel slotted channel.
- 5. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- 6. 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 or required by Code:
  - a. To Wood: Fasten with lag screws or through bolts.
  - b. To New Concrete: Bolt to concrete inserts.
  - c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - d. To Existing Concrete: Expansion anchor fasteners.
  - e. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - f. To Light Steel: Sheet metal screws.
  - g. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount on slotted-channel racks attached to substrate.
- 7. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

# 3.3 WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway
- B. Exposed Feeders, Branch Circuits, and Class 1 Control Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.
- C. Feeders and Branch Circuits Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.
- D. Feeders and Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and underground: Type THHN-THWN, single conductors in raceway.
- E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainlesssteel, wire-mesh, and strain relief device at terminations to suit application.
- F. Class 2 Control Circuits: Type THHN-THWN, in raceway.

#### 3.4 GROUNDING

A. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum. Bury at least 24 inches below grade.

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- B. Pipe and Equipment Grounding Conductor Terminations: Bolted.
- C. Underground Connections: Welded.
- D. Connections to Structural Steel: Bolted.
- E. Install grounding conductors routed 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.
- F. Install ground rods driven into ground until tops are 2 inches below final grade, or 4 inches above, finished floor slab unless otherwise indicated.
- G. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape.
- H. Make connections without exposing steel or damaging coating if any.
- I. Install bonding straps and jumpers in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
- J. Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
- K. Bond to equipment mounted on vibration isolation hangers and supports so vibration is not transmitted to rigidly mounted equipment.
- L. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- M. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
  - 1. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
  - 2. Perform tests by fall-of-potential method according to IEEE 81.
  - 3. Report measured ground resistances that exceeds 10 ohms.
  - 4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

### 3.5 IDENTIFICATION

- A. Power-Circuit Conductor Identification: For No. 3 AWG conductors and larger, at each location where observable, identify phase using color-coding conductor tape.
- B. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring.
- C. Warning Labels for Enclosures for Power and Lighting: Comply with 29 CFR 1910.145; identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- D. Equipment Identification Labels:
  - 1. Labeling Instructions:
    - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label, drilled for screw attachment.
    - c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.
  - 2. Equipment to Be Labeled:
    - a. Panelboards, electrical cabinets, and enclosures.
    - b. Electrical switchgear and switchboards.
    - c. Transformers.
    - d. Motor-control centers.
    - e. Disconnect switches.
    - f. Enclosed circuit breakers.
    - g. Motor starters.
    - h. Push-button stations.
    - i. Power transfer equipment.
    - j. Contactors.
- E. Verify identity of each item before installing identification products.
- F. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- G. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- H. Install system identification color banding for raceways and cables at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- I. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Ungrounded service, feeder and branch-circuit conductors.

- 1. Colors for 208/120-V Circuits:
  - a. Phase A: Black.
  - b. Phase B: Red.
  - c. Phase C: Blue.
- 2. Colors for 480/277-V Circuits:
  - a. Phase A: Brown.
  - b. Phase B: Orange.
  - c. Phase C: Yellow.
- 3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points.
- J. Underground-Line Warning Tape: Continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade.

### 3.6 SEISMIC REQUIREMENTS

- A. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.
- B. Install bushing assemblies for anchor bolts for wall- and floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in substrate.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.
- D. Accommodation of Differential Seismic Motion: Make flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element than the one supporting them as they approach equipment.

#### 3.7 SLEEVE AND SLEEVE-SEALS INSTALLATION

- A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- B. Cut sleeves to length for mounting flush with both wall surfaces.
- C. Extend sleeves installed in floors 2 inches above finished floor level.
- D. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
- E. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

- F. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Section 079200 "Joint Sealants."
- G. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- H. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- I. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

## 3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Section 078413 "Penetration Firestopping."

# END OF SECTION 260500

# SECTION 260519 – LOW-VOLTAGE ELCTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

### 1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Nonmetallic-sheathed cable.
- C. Service entrance cable.
- D. Metal-clad cable.
- E. Wiring connectors and connections for 600 volts or less.
- F. Electrical tape.
- G. Heat shrink tubing.
- H. Oxide inhibiting compound.
- I. Wire pulling lubricant.

#### 1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 Firestopping.
- B. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- C. Section 28 31 00 Fire Detection and Alarm: Fire alarm system conductors and cables.

### 1.3 REFERENCE STANDARDS

- A. ASTM B3 Standard Specification for Soft or Annealed Copper Wire; 2001 (Reapproved 2007).
- B. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010.
- D. ASTM B787/B787M Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2009).

- E. ASTM B800 Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes Annealed and Intermediate Tempers; 2005.
- F. ASTM B801 Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2007.
- G. ASTM D3005 Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
- H. ASTM D4388 Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2008.
- I. NECA 1 Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- J. NECA 104 Recommended Practice for Installing Aluminum Building Wire and Cable; National Electrical Contractors Association; 2006 (NECA/AA 104).
- K. NECA 120 Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); National Electrical Contractors Association; 2006.
- L. NECA 121 Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF); National Electrical Contractors Association; 2007.
- M. NEMA WC 70 Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009 (ANSI/NEMA WC 70/ICEA S-95-658).
- N. NETA STD ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- O. NFPA 70 National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. UL 44 Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- Q. UL 83 Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- R. UL 486A-486B Wire Connectors; Current Edition, Including All Revisions.
- S. UL 486C Splicing Wire Connectors; Current Edition, Including All Revisions.
- T. UL 486D Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- U. UL 510 Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- V. UL 719 Nonmetallic-Sheathed Cables; Current Edition, Including All Revisions.
- W. UL 854 Service-Entrance Cables; Current Edition, Including All Revisions.

#### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

X. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

## 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
  - 3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

### 1.5 SUBMITTALS

- A. See Administrative Requirements for general submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

## 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction, and marked for its intended use.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

### 1.8 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

- B. Comply with NEMA WC 70 for copper and aluminum conductors including their insulation materials.
- C. Comply with NEMA WC 5.

## PART 2 - PRODUCTS

## 2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Metal-clad cable is permitted only as follows:
  - 1. Where not otherwise restricted, may be used:
    - a. Where concealed in hollow stud walls, above accessible ceilings.
  - 2. In addition to other applicable restrictions, may not be used:
    - a. Where exposed to view.
    - b. Where exposed to damage.
    - c. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.

## 2.2 CONDUCTOR AND CABLE MANUFACTURERS

- A. Cerro Wire LLC: www.cerrowire.com.
- B. Industrial Wire & Cable, Inc: www.iewc.com.
- C. Southwire Company: www.southwire.com.
- D. Alcan; Model Stabiloy: www.cable.alcan.com
- E. Belden: www.belden.com.
- F. General Cable: www.generalcable.com
- G. USA Cable: www.USAwire-cable.com
- H. AmerCable: www.amercable.com
- I. Substitutions: See Section 01 60 00 Product Requirements.

#### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### 2.3 ALL CONDUCTORS AND CABLES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
  - 1. Provide copper conductors except where aluminum conductors are specifically indicated or permitted for substitution. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
    - a. Substitution of aluminum conductors for copper is permitted, when approved by Owner and authority having jurisdiction, only for the following:
      - 1) Services: Copper conductors size 3 AWG or larger.
      - 2) Feeders: Copper conductors size 3 AWG or larger.
    - b. Where aluminum conductors are substituted for copper, comply with the following:
      - 1) Size aluminum conductors to provide, when compared to copper sizes indicated, equivalent or greater ampacity and equivalent or less voltage drop.
      - 2) Increase size of raceways, boxes, wiring gutters, enclosures, etc. as required to accommodate aluminum conductors.
      - 3) Provide aluminum equipment grounding conductor sized according to NFPA 70.
  - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
  - 3. Tinned Copper Conductors: Comply with ASTM B33.
  - 4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.
- H. Minimum Conductor Size:
  - 1. Branch Circuits: 12 AWG.
    - a. Exceptions:
      - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
      - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.

- I. Conductor Color Coding:
  - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
  - 2. Color Coding Method: Integrally colored insulation.
    - a. Conductors size 6 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
  - 3. Color Code:
    - a. 208Y/120 V, 3 Phase, 4 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
      - 4) Neutral/Grounded: White.
    - b. Equipment Ground, All Systems: Green.

# 2.4 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
  - 1. Copper Building Wire:
    - a. Cerro Wire LLC: www.cerrowire.com.
    - b. Encore Wire Corporation: www.encorewire.com.
    - c. Southwire Company: www.southwire.com.
    - d. Substitutions: See Section 01 60 00 Product Requirements.
  - 2. Aluminum Building Wire (only where specifically indicated or permitted for substitution):
    - a. Alcan Products Corporation/Alcan Cable: www.cable.alcan.com.
    - b. Prysmian Power Cables and Systems: www.us.prysmian.com.
    - c. Southwire Company: www.southwire.com.
    - d. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
  - 1. Feeders and Branch Circuits:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
  - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
  - 2. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.

## 2.5 METAL-CLAD CABLE

- A. Manufacturers:
  - 1. AFC Cable Systems Inc: www.afcweb.com.
  - 2. Encore Wire Corporation: www.encorewire.com.
  - 3. Southwire Company: www.southwire.com.
  - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
  - 1. Size 10 AWG and Smaller: Solid.
  - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
- F. Grounding: Full-size integral equipment grounding conductor.
- G. Armor: Steel, interlocked tape.
- H. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

#### 2.6 WIRING CONNECTORS AND TERMINATIONS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Wiring Connectors for Splices and Taps:
  - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
  - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
  - 3. Connectors for Aluminum Conductors: Use compression connectors.
- C. Wiring Connectors for Terminations:
  - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
  - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
  - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
  - 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.

- D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- F. Mechanical Connectors: Provide bolted type or set-screw type.
- G. Compression Connectors: Provide circumferential type or hex type crimp configuration.
- H. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

## 2.7 WIRING ACCESSORIES

- A. Electrical Tape:
  - 1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
  - 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
  - 3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
  - 4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
  - 5. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
  - 6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, allweather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as shown on the drawings.
- E. Verify that conditions are satisfactory for installation prior to starting work.

## 3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

# 3.3 INSTALLATION

- A. Circuiting Requirements:
  - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
  - 2. When circuit destination is indicated and routing is not shown, determine exact routing required.
  - 3. Arrange circuiting to minimize splices.
  - 4. Include circuit lengths required to install connected devices within 10 ft of location shown.
  - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
  - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
  - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:
    - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
    - b. Increase size of conductors as required to account for ampacity derating.
    - c. Size raceways, boxes, etc. to accommodate conductors.
  - 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is permitted where not otherwise prohibited, except for the following:
    - a. Branch circuits fed from ground fault circuit interrupter (GFCI) circuit breakers.
    - b. Branch circuits fed from feed-through protection of GFI receptacles.
    - c. Branch circuits with dimming controls.
    - d. Branch circuits with isolated grounding conductor.
- B. Install products in accordance with manufacturer's instructions.

- C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- D. Install aluminum conductors in accordance with NECA 104.
- E. Install metal-clad cable (Type MC) in accordance with NECA 120.
- F. Installation in Raceway:
  - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
  - 2. Pull all conductors and cables together into raceway at same time.
  - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
  - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
  - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
  - 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- I. Terminate cables using suitable fittings.
  - 1. Metal-Clad Cable (Type MC):
    - a. Use listed fittings.
    - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- J. Install conductors with a minimum of 12 inches of slack at each outlet.
- K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- M. Make wiring connections using specified wiring connectors.
  - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
  - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
  - 3. Do not remove conductor strands to facilitate insertion into connector.
  - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

- 5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
- 6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
- 7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
  - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
    - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
    - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
  - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
    - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
    - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
  - 3. Wet Locations: Use heat shrink tubing.
- O. Insulate ends of spare conductors using vinyl insulating electrical tape.
- P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- Q. Identify conductors and cables in accordance with Section 26 05 53.
- R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- T. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface. Support and train all feeders within switchboards away from open bus bars and sharp metal edges within cabinets.
- U. Neatly train and lace wiring inside boxes, equipment, and panelboards.

## 3.4 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Perform inspections and tests listed in NETA STD ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 260519

# SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

### 1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Provide all components necessary to complete the grounding system(s) consisting of:
  - 1. Existing metal underground water pipe.
  - 2. Metal underground water pipe.
  - 3. Metal frame of the building.
  - 4. Concrete-encased electrode.
  - 5. Metal underground gas piping system.
  - 6. Rod electrodes.

### 1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.

#### 1.3 REFERENCE STANDARDS

- A. NECA 1 Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NETA STD ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- C. NFPA 70 National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 467 Grounding and Bonding Equipment; Current Edition, Including All Revisions.

### 1.4 PERFORMANCE REQUIREMENTS

## 1.5 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements for submittals procedures.
- B. Product Data: Provide for grounding electrodes, connections and specific purpose conductors.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Project Record Documents: Record actual locations of components and grounding electrodes.
- E. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

### 1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

### PART 2 - PRODUCTS

### 2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

#### 2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
  - 1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
  - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 05 19:
  - 1. Use insulated copper conductors unless otherwise indicated.
    - a. Exceptions:
      - 1) Use bare copper conductors where installed underground in direct contact with earth.

- 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
  - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
  - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
  - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
- D. Cooper Power Systems, a division of Cooper Industries: www.cooperindustries.com.
- E. Framatome Connectors International: www.fciconnect.com.
- F. Lightning Master Corporation: www.lightningmaster.com.
- G. Substitutions: See Section 01 60 00 Product Requirements.

# 2.3 CONNECTORS AND ACCESSORIES

- A. Mechanical (Bolted) Connectors.
  - 1. Bolted connectors for conductors and pipes: bronze, copper, and copper alloy, bolted compression type specifically manufactured for application needed.
  - 2. Pipe connectors, clamp type, sized for pipe to be grounded.
  - 3. Product: CADWELD manufactured by Erico.
  - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Exothermic Connections:
  - 1. Uses required: all concealed underground and structural steel.
  - 2. Product: CADWELD manufactured by Erico.
  - 3. Product: ULTRAWELD manufactured by Harger.
  - 4. Product: EXOWELD manufactured by LP1.
  - 5. Substitutions: See Section 01 60 00 Product Requirements.
- C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.

- D. Verify existing conditions prior to beginning work.
- E. Verify that final backfill and compaction has been completed before driving rod electrodes.

## 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Make grounding and bonding connections using specified connectors.
  - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
  - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
  - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
  - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 26 05 53.
- E. Install ground electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
  - 1. Drive electrodes down until tops are at least 2" below finished grade, unless indicated otherwise.
  - 2. Interconnect grounding electrodes with buried bare copper, 3/0 minimum size. Bury conductor at least 24" below finished grade.
  - 3. Grounding electrode system shall consist of at least 3 electrodes spaced at least 10' apart preferably in a triangle arrangement.
- F. Provide grounding well with cover at rod locations where indicated. Install with top flush to finished grade.
- G. Install bare copper wire in foundation footing where indicated.
- H. Provide bonding to meet requirements described in Quality Assurance. Bond in area readily accessible for inspection and maintenance, except for short runs in conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to/from rigidly mounted equipment.
  - 3. Exothermic Welded Connections: required for all buried connections except where specifically noted to do otherwise.

- 4. Metal Water Service Pipe: Install insulated copper grounding conductors (in conduit) from building's main service equipment or grounding bus to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts on the flange. Where a dielectric main water fitting is installed, conduit or sleeve to conductor at each end.
- 5. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
- 6. Above Ground Portion of Gas Piping System downstream from equipment shutoff valve.
- I. Equipment/Device Specific Grounding & Bonding Requirements: Provide separate, insulated conductor within each feeder and branch circuit raceway according NFPA 70. Terminate each end on suitable lug, bus, or bushing.
  - 1. In addition to NFPA 70 requirements, provide insulated grounding conductors for:
    - a. Feeders and branch circuits.
    - b. Lighting circuits.
    - c. Receptacle circuits.
    - d. Single phase motor and appliance circuits.
    - e. 3-phase motor and appliance circuits.
    - f. Flexible raceway runs.
    - g. Armored and metal-clad cable runs.
  - 2. Air-duct Equipment Circuits: Install insulated equipment grounding conductor to ductmounted 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.
  - 3. Water Heater, Heat Tracing, and Anti frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment and components.
  - 4. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
  - 5. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4" x 2" x 12" grounding bus.
  - 6. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
  - 7. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch circuit conductors.

# 3.3 FIELD QUALITY CONTROL

- A. Owner will provide field inspection in accordance with Section 01 40 00.
- B. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- C. Inspect and test in accordance with NETA STD ATS except Section 4.
- D. Perform inspections and tests listed in NETA STD ATS, Section 7.13.

- E. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- F. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION 260526

# SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

### 1.1 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.
- C. Equipment concrete pad requirements.

### 1.2 RELATED REQUIREMENTS

A. General Conditions, Supplementary Conditions and Division 01 apply to this section.

#### 1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2009.
- B. ICC-ES AC01 Acceptance Criteria for Expansion Anchors in Masonry Elements; 2009.
- C. ICC-ES AC106 Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2006
- D. ICC-ES AC193 Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2010
- E. ICC-ES AC308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2009.
- F. NECA 1 Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- G. NFPA 70 National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

### 1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

## 1.5 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog data for fastening systems.
- C. Welding certificates.

#### 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- C. Welding: Qualify procedures and personnel according to AW D1.1/D1.1M, "Structural Welding Code Steel."

PART 2 - GENERAL

### 2.1 MATERIALS -- SUPPORT AND ATTACHMENT COMPONENTS

- A. Hangers and Supports General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; hot-dipped galvanized after fabrication and applied according to MFMA-4.
  - 1. Manufacturers -- Subject to compliance with requirements, manufacturers offering products that may be incorporated into the WORK include but are not limited to the following:
    - a. Allied Tube and Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation
    - d. GS Metals Corporation.
    - e. Thomas and Betts Corporation
    - f. Unistrut; Tyco International, Ltd.
  - 2. Channel/strut dimensions: as selected for applicable load criteria.
  - 3. Raceway and cable supports as described in NECA 1 and NECA 101.
  - 4. Conduit and cable support devices -- hangers, clamps and associated fittings, designed for types and sizes of raceway or cable to be supported.
  - 5. Supports for Conductors in Vertical Conduit -- Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
  - 6. Structural Steel for Fabricated Supports and Restraints -- ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- C. Mounting Anchoring and Attachment Components -- Items for fastening electrical items, or their supports, to building surfaces including 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 the supported loads and building materials where used. Coordinate usage with General Contractor on precast structural members.
    - 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) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Stong-Tie Company Inc., Masterset Fastening Systems Unit.
  - 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 in which used.
    - a. Available Manufacturers: Subject to the compliance with requirements, manufacturers offering products that may be incorporated into the WORK include, but are not limited to, the following:
      - 1) Cooper B-Line; a division of Cooper Industries.
      - 2) Empire Tool and manufacturing Company, Inc.
      - 3) Hilti Inc.
      - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
  - 3. Concrete Inserts: Steel or malleable iron, slotted support system units similar to MSS, Type 18; comply with MFMA-4 or MSS SP-58.
  - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 5. Through Bolts: Structural type, hex head and high strength. Comply with ASTM A 325.
  - 6. Toggle Bolts: All steel, spring head type.
  - 7. Hanger rods: threaded steel.
- D. Fabricated Metal Equipment Support Assemblies
  - 1. Description: Welded or bolted, structural steel shapes, shop or field fabricated to fit dimensions of supported equipment.
  - 2. Materials: Comply with requirements in Division 5 Section, "Metal Fabrications" for steel shapes and plates.
- E. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
  - 1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
  - 2. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
  - 3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.

- 4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- 5. Manufacturers:
  - a. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
  - b. PHP Systems/Design: www.phpsd.com.
  - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
  - d. Substitutions: See Section 01 60 00 Product Requirements.

## PART 3 - EXECUTION

## 3.1 APPLICATION

- A. Comply with NECA 1 and NECA101 for applications of hangers and supports for electrical equipment and systems except if requirements in this section are more stringent.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC and RMC as required by NFPA 70. Minimum rod size shall be 1/4" in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25% in the future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

## 3.2 INSTALLATION

- A. Supports
  - 1. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
  - 2. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
  - 3. 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.
  - 4. 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:
    - a. To Wood: Fasten with lag screws or through bolts.
    - b. To New Concrete: Bolt to concrete inserts.
    - c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    - d. To Existing Concrete: Expansion anchor fasteners.
    - e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4
inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

- f. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
- g. To Light Steel: Sheet metal screws.
- h. 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 by means that meet seismic-restraint strength and anchorage requirements.
- 5. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- B. Installation of Fabricated Metal Supports
  - 1. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
  - 2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
  - 3. Field Welding: Comply with AWS D1.1/D1.1M
- C. Concrete Bases
  - 1. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
  - 2. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3.
  - 3. Anchor equipment to concrete base.
    - a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - b. Install anchor bolts to elevations required for proper attachment to supported equipment.
    - c. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- D. Painting
  - 1. Touchup: Comply with requirements in Division 9 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
  - 2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- E. Install hangers and supports as required to adequately and securely support electrical system components, in a neat and workmanlike manner, as specified in NECA 1.
  - 1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
  - 2. Obtain permission from Engineer before drilling or cutting structural members.
- F. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

- G. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- H. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
- I. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

# SECTION 260534 - CONDUIT

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Aluminum rigid metal conduit (RMC).
- C. Intermediate metal conduit (IMC).
- D. PVC-coated galvanized steel rigid metal conduit (RMC).
- E. Flexible metal conduit (FMC).
- F. Liquid-tight flexible metal conduit (LFMC).
- G. Electrical metallic tubing (EMT).
- H. Rigid polyvinyl chloride (PVC) conduit.
- I. Liquid-tight flexible nonmetallic conduit (LFNC).
- J. Conduit fittings.
- K. Accessories.

## 1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 07 84 00 Firestopping.
- C. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC) and armored cable (Type AC), including uses permitted.
- D. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- E. Section 26 05 29 Hangers and Supports for Electrical Systems.
- F. Section 26 05 35 Surface Raceways.
- G. Section 26 05 37 Boxes.
- H. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.

I. Section 26 27 01 - Electrical Service Entrance: Additional requirements for electrical service conduits.

## 1.3 REFERENCE STANDARDS

- A. ANSI C80.1 American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
- B. ANSI C80.3 American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
- C. ANSI C80.5 American National Standard for Electrical Rigid Aluminum Conduit (ERAC); 2005.
- D. ANSI C80.6 American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- E. NECA 1 Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- F. NECA 101 Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.
- G. NECA 102 Standard for Installing Aluminum Rigid Metal Conduit; National Electrical Contractors Association; 2004.
- H. NECA 111 Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.
- I. NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2007.
- J. NEMA RN 1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association; 2005.
- K. NEMA TC 2 Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2003.
- L. NEMA TC 3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2004.
- M. NEMA TC 7 Smooth Wall Coilable Electrical Polyethylene Conduit and fittings; National Electrical Manufacturers Association, 2005. Comply with ASTM 2160 and UL 651B.
- N. NEMA TC-14 Reinforced Thermosetting Resin Conduit (RTRC) and fittings; National Electrical Manufacturers Association; 2002. UL 1684.
- O. NFPA 70 National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. UL 1 Flexible Metal Conduit; Current Edition, Including All Revisions.

- Q. UL 6 Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- R. UL 6A Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- S. UL 360 Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- T. UL 514B Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- U. UL 651 Schedule 40 and 80 Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- V. UL 797 Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- W. UL 1242 Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
- X. UL 1660 Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

# 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
  - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
  - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
  - 5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
  - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

## 1.5 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

- D. Product Data: Provide for metallic conduit, flexible metal conduit, liquid-tight flexible metal conduit, metallic tubing, nonmetallic conduit, flexible nonmetallic conduit, nonmetallic tubing, fittings, and conduit bodies.
- 1.6 QUALITY ASSURANCE
  - A. A. Conform to requirements of NFPA 70.
- 1.7 DELIVERY, STORAGE, AND HANDLING
  - A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

# PART 2 - PRODUCTS

## 2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
  - 1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
  - 2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
  - 3. Exterior, Embedded Within Concrete: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
  - 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
  - 5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
  - 6. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
  - 7. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.
- D. Embedded Within Concrete:

- 1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
- 2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
- 3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
- 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
- E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- F. Concealed Within Hollow Metal Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
  - 1. Locations subject to physical damage include, but are not limited to:
    - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.
- L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- M. Corrosive Locations Above Ground: Use PVC-coated galvanized steel rigid metal conduit or aluminum rigid metal conduit.
- N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
  1. Maximum Length: 6 feet.
- O. Connections to Vibrating Equipment:
  - 1. Dry Locations: Use flexible metal conduit.
  - 2. Damp, Wet, or Corrosive Locations: Use liquid-tight flexible metal conduit.
  - 3. Maximum Length: 6 feet unless otherwise indicated.
  - 4. Vibrating equipment includes, but is not limited to:

- a. Transformers.
- b. Motors.

# 2.2 CONDUIT REQUIREMENTS

- A. Electrical Service Conduits: Also comply with Section 26 27 01.
- B. Communications Systems Conduits: Also comply with Section 27 05 28.
- C. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- D. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
- E. Minimum Conduit Size, Unless Otherwise Indicated:
  - 1. Branch Circuits: 1/2 inch (16 mm) trade size.
  - 2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
  - 3. Control Circuits: 1/2 inch (16 mm) trade size.
  - 4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
  - 5. Underground, Interior: 3/4 inch (21 mm) trade size.
  - 6. Underground, Exterior: 1 inch (27 mm) trade size.
- F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

# 2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
  - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use steel or malleable iron.
  - 3. Connectors and Couplings: Use threaded type fittings only. Thread-less set screw and compression (gland) type fittings are not permitted.

## 2.4 ALUMINUM RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.
- B. Fittings:
  - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use aluminum.
  - 3. Connectors and Couplings: Use threaded type fittings only. Thread-less set screw and compression (gland) type fittings are not permitted.

#### 2.5 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

#### B. Fittings:

- 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
- 2. Material: Use steel or malleable iron.
- 3. Connectors and Couplings: Use threaded type fittings only. Thread-less set screw and compression (gland) type fittings are not permitted.

#### 2.6 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- C. PVC-Coated Fittings:
  - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
  - 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
  - 3. Material: Use steel or malleable iron.
  - 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

## 2.7 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- B. Fittings:
  - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use steel or malleable iron.

#### 2.8 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
  - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

- 2. Material: Use steel or malleable iron.
- C. Description: Interlocked steel construction with PVC jacket.

# 2.9 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
  - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
  - 2. Material: Use steel or malleable iron.
  - 3. Connectors and Couplings: Use compression (gland) or set-screw type.
    - a. Do not use indenter type connectors and couplings.

# 2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- B. Fittings:
  - 1. Manufacturer: Same as manufacturer of conduit to be connected.
  - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

## 2.11 LIQUID-TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

- A. Description: NFPA 70, Type LFNC liquid-tight flexible nonmetallic conduit listed and labeled as complying with UL 1660.
- B. Fittings:
  - 1. Manufacturer: Same as manufacturer of conduit to be connected.
  - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

## 2.12 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
- E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

## PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify routing and termination locations of conduit prior to rough-in.
- E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

#### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.
- E. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- H. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.
- I. Conduit Routing:
  - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
  - 2. When conduit destination is indicated and routing is not shown, determine exact routing required.
  - 3. Conceal all conduits unless specifically indicated to be exposed.
  - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
    - a. Electrical rooms.

- b. Mechanical equipment rooms.
- c. Within joists in areas with no ceiling.
- 5. Unless otherwise approved, do not route conduits exposed:
  - a. Across floors.
  - b. Across roofs.
  - c. Across top of parapet walls.
  - d. Across building exterior surfaces.
- 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
- 7. Arrange conduit to maintain adequate headroom, clearances, and access.
- 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
- 9. Route conduits above water and drain piping where possible.
- 10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
- 11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
- 12. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to.
  - a. Heaters.
  - b. Hot water piping.
  - c. Flues.
- 13. Group parallel conduits in the same area together on a common rack.
- J. Conduit Support:
  - 1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
  - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
  - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
- K. Connections and Terminations:
  - 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
  - 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
  - 3. Use suitable adapters where required to transition from one type of conduit to another.
  - 4. Provide drip loops for liquid-tight flexible conduit connections to prevent drainage of liquid into connectors.
  - 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and rain-tight hubs for wet locations.
  - 6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
  - 7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

- L. Penetrations:
  - 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
  - 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
  - 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
  - 4. Conceal bends for conduit risers emerging above ground.
  - 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
  - 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
  - 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
  - 8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- M. Underground Installation:
  - 1. Minimum Cover, Unless Otherwise Indicated or Required:
    - a. Underground, Exterior: 24 inches.
    - b. Under Slab on Grade: 12 inches to bottom of slab.
  - 2. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length for service entrance where not concrete-encased.
- N. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
  - 1. Maximum Conduit Size: 1 inch (27 mm) unless otherwise approved.
  - 2. Install conduits within middle one third of slab thickness.
  - 3. Secure conduits to prevent floating or movement during pouring of concrete.
- O. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- P. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
  - 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
  - 2. Where conduits are subject to earth movement by settlement or frost.
- Q. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
  - 1. Where conduits pass from outdoors into conditioned interior spaces.
  - 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- R. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

- S. Provide grounding and bonding in accordance with Section 26 05 26.
- T. Identify conduits in accordance with Section 26 05 53.
- 3.3 FIELD QUALITY CONTROL
  - A. See Section 01 40 00 Quality Requirements, for additional requirements.
  - B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
  - C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
  - D. Correct deficiencies and replace damaged or defective conduits.

# 3.4 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

## 3.5 **PROTECTION**

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

# SECTION 260537 - BOXES

PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Wall and ceiling outlet boxes.
- B. Floor boxes.
- C. Pull and junction boxes.

# 1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 Firestopping.
- B. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 27 26 Wiring Devices: Wall plates in finished areas.

## 1.3 REFERENCE STANDARDS

- A. NECA 1 Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- B. NEMA FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2007.
- C. NEMA OS 1 Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008.
- D. NEMA OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 2008.
- E. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.
- F. NFPA 70 National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

## 1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.
- 1.5 QUALITY ASSURANCE
  - A. Conform to requirements of NFPA 70.
  - B. Products: Provide products listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

## PART 2 - PRODUCTS

#### 2.1 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
  - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
  - 2. Concrete Ceiling Boxes: Concrete type.
- B. Nonmetallic Outlet Boxes: NEMA OS 2, for use in dwelling units in Type II, IV, and V construction.
- C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- E. Television Wall Boxes: Provide for FSR #PWB-250 project wall box at each individual wallmounted television.

## 2.2 FLOOR BOXES

- A. Floor Boxes: NEMA OS 1, fully adjustable, 1-1/2 inches deep.
- B. Material: Cast metal.
- C. Shape: Round.
- D. Service Fittings: As specified in Section 26 27 26.

## 2.3 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- C. Coordinate installation of outlet boxes for equipment connected under Section 26 27 17.
- D. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- E. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
  - 1. Adjust box locations up to 10 feet if required to accommodate intended purpose.
- F. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- G. Maintain headroom and present neat mechanical appearance.
- H. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- I. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- J. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- K. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- L. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- M. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- N. Use flush mounting outlet box in finished areas.
- O. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- P. Provide separate boxes for emergency power and normal power systems.
- Q. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- R. Locate outlet boxes so that wall plates do not span different building finishes.
- S. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation.
  - 1. Provide minimum 24 inches separation in acoustic rated walls.
  - 2. Provide minimum 24 inches separation in fire rated walls.

- T. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- U. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- V. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- W. Provide vapor sealing type boxes or additional vapor barrier enclosures around boxes located in exterior walls in wood or metal stud framing.
- X. Use adjustable steel channel fasteners for hung ceiling outlet box.
- Y. Do not fasten boxes to ceiling support wires.
- Z. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
- AA. Use gang box where more than one device is mounted together. Do not use sectional box.
- AB. Use gang box with plaster ring for single device outlets in Type I and II construction areas.
- AC. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- AD. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- AE. Set floor boxes level.
- AF. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.
- AG. Identify boxes in accordance with Section 26 05 53.

# 3.2 ADJUSTING

- A. Adjust floor boxes flush with finish flooring material.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused box openings.

## 3.3 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

# SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

#### 1.2 RELATED REQUIREMENTS

- A. Section 09 90 00 Painting and Coating.
- B. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- C. Section 26 27 26 Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.

#### 1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 American National Standard for Environmental and Facility Safety Signs; 2007.
- B. ANSI Z535.4 American National Standard for Product Safety Signs and Labels; 2007.
- C. NFPA 70 National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 70E Standard for Electrical Safety in the Workplace; 2009.
- E. UL 969 Marking and Labeling Systems; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
  - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
  - 2. Do not install identification products until final surface finishes and painting are complete.

## 1.5 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
- 1.6 QUALITY ASSURANCE
  - A. Conform to requirements of NFPA 70.

#### 1.7 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

## PART 2 - PRODUCTS

## 2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
  - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
    - a. Switchboards:
      - 1) Identify power source and circuit number. Include location when not within sight of equipment.
      - 2) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

b. Panelboards:

- 1) Identify power source and circuit number. Include location when not within sight of equipment.
- 2) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
- 3) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
- 4) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
- c. Enclosed switches, circuit breakers, and motor controllers:
  - 1) Identify power source and circuit number. Include location when not within sight of equipment.
  - 2) Identify load(s) served. Include location when not within sight of equipment.
- d. Time Switches:
  - 1) Identify load(s) served and associated circuits controlled. Include location.
- e. Enclosed Contactors:
  - 1) Identify ampere rating.
  - 2) Identify voltage and phase.
  - 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
  - 4) Identify coil voltage.
  - 5) Identify load(s) and associated circuits controlled. Include location.
- f. Transfer Switches:
  - 1) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
- 2. Service Equipment:
  - a. Use identification nameplate to identify each service disconnecting means.
  - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
  - c. Use identification nameplate at each piece of service equipment to identify the available fault current and the date calculations were performed.
- 3. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
- 4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
- 5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.

- 6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
- 7. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
- 8. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
  - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 90 00.
- 9. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
  - a. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
- B. Identification for Conductors and Cables:
  - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
  - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
  - 3. Use underground warning tape to identify direct buried cables.
- C. Identification for Raceways:
  - 1. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
    - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
      - 1) Color Code:
        - (a) Fire Alarm System: Red.
      - 2) Field-Painting: Comply with Section 09 90 00.
      - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 05 19.
  - 2. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
  - 3. Use underground warning tape to identify underground raceways.
- D. Identification for Boxes:
  - 1. Use voltage markers or color coded boxes to identify systems other than normal power system.

- a. Color-Coded Boxes: Field-painted in accordance with Section 09 90 00 per the same color code used for raceways.
  - 1) Fire Alarm System: Red.
- 2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
  - a. For exposed boxes in public areas, use only identification labels.
- E. Identification for Devices:
  - 1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
  - 2. Use identification label to identify fire alarm system devices.
  - 3. Use identification label or engraved wallplate to identify load controlled for wallmounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
  - 4. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

# 2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
  - 1. Materials:
    - a. Indoor Clean, Dry Locations: Use plastic nameplates.
    - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
  - 2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically nonconductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
    - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
  - 3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
  - 4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laseretched text.
  - 5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
  - 1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
  - 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
  - 1. Minimum Size: 1 inch by 2.5 inches.
  - 2. Legend:
    - a. System designation where applicable:

- 1) Fire Alarm System: Identify with text "FIRE ALARM".
- b. Equipment designation or other approved description.
- 3. Text: All capitalized unless otherwise indicated.
- 4. Minimum Text Height:
  - a. System Designation: 1 inch.
  - b. Equipment Designation: 1/2 inch.
- 5. Color:
  - a. Normal Power System: White text on black background.
  - b. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
  - 1. Minimum Size: 1 inch by 2.5 inches.
  - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 1/4 inch.
  - 5. Color: Black text on white background unless otherwise indicated.
- E. Format for Caution and Warning Messages:
  - 1. Minimum Size: 2 inches by 4 inches.
  - 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 1/2 inch.
  - 5. Color: Black text on yellow background unless otherwise indicated.
- F. Format for Receptacle Identification:
  - 1. Minimum Size: 3/8 inch by 1.5 inches.
  - 2. Legend: Power source and circuit number or other designation indicated.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch.
  - 5. Color: Black text on clear background.
- G. Format for Control Device Identification:
  - 1. Minimum Size: 3/8 inch by 1.5 inches.
  - 2. Legend: Load controlled or other designation indicated.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch.
  - 5. Color: Black text on clear background.
- H. Format for Fire Alarm Device Identification:
  - 1. Minimum Size: 3/8 inch by 1.5 inches.
  - 2. Legend: Designation indicated and device zone or address.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch.
  - 5. Color: Red text on white background.

#### **IDENTIFICATION FOR ELECTRICAL SYSTEMS**

## 2.3 WIRE AND CABLE MARKERS

- A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- C. Legend: Power source and circuit number or other designation indicated.
- D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- E. Minimum Text Height: 1/8 inch.
- F. Color: Black text on white background unless otherwise indicated.

#### 2.4 VOLTAGE MARKERS

- A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- C. Minimum Size:
  - 1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
  - 2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
  - 3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- D. Legend:
  - 1. Markers for System Identification:
- E. Color: Black text on orange background unless otherwise indicated.

#### 2.5 UNDERGROUND WARNING TAPE

- A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- C. Legend: Type of service, continuously repeated over full length of tape.
- D. Color:

#### 2.6 FLOOR MARKING TAPE

A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

#### 2.7 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
  - 1. Materials:
  - 2. Minimum Size: 7 by 10 inches unless otherwise indicated.

#### C. Warning Labels:

- 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or selfadhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
  - a. Do not use labels designed to be completed using handwritten text.
- 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
- 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

#### PART 3 - PRODUCTS

#### 3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

#### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
  - 1. Surface-Mounted Equipment: Enclosure front.
  - 2. Flush-Mounted Equipment: Inside of equipment door.
  - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
  - 4. Elevated Equipment: Legible from the floor or working platform.
  - 5. Branch Devices: Adjacent to device.
  - 6. Interior Components: Legible from the point of access.
  - 7. Conduits: Legible from the floor.
  - 8. Boxes: Outside face of cover.
  - 9. Conductors and Cables: Legible from the point of access.
  - 10. Devices: Outside face of cover.

- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Mark all handwritten text, where permitted, to be neat and legible.

#### 3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

# SECTION 260583 – ELECTRICAL CONNECTIONS TO EQUIPMENT

PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this Section.
- B. This Section is a Division 26 Basic Materials and Methods Section and is part of each Division 22, 23 and 26 section making reference to electrical connections for equipment specified herein.

## 1.2 DESCRIPTION OF WORK

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Applications of electrical power connections specified in this section include the following:
  - 1. To motors.
  - 2. To temperature control equipment
  - 3. To elevators
- C. Electrical connections for equipment not furnished as integral part of equipment are specified in Divisions 22, 23 and other Division 26 sections, and are work of this section.
- D. Motor starters and controllers not furnished as integral part of equipment are specified in applicable Division 26 sections.
- E. Refer to Divisions 22 and 23 sections for motor starters and controllers furnished integrally with equipment.
- F. Refer to Divisions 22 and 23 sections for connection requirements for temperature control equipment.
- G. Junction boxes and disconnect switches required for connection motors and other electrical units of equipment are specified in applicable Division 26 sections.

## 1.3 QUALITY ASSURANCE

- A. NEC Compliance. Comply with applicable requirements of NEC as to type of products used and installation of electrical power connections (terminals and splices) for junction boxes, motor starters, and disconnect switches.
- B. ANSI Compliance. Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

C. Compliance with Testing Laboratories. Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors", including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials that are listed and labeled by nationally-recognized testing laboratories.

#### 1.4 SHOP DRAWINGS

A. Shop drawings are not required for work described in this section.

## PART 2 - PRODUCTS

## 2.1 MATERIALS AND COMPONENTS

- A. General: For each electrical connection indicated, provide complete assembly of materials, including, but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations.
- B. Raceways and fittings. Provide raceways and fittings of types, grades, sizes, and weights (wall thicknesses) indicated for each type service. Provide products complying with Section 26 05 34.
- C. Wires, Cables, and Connectors. Provide wires, cables, and connectors complying with Division 26 05 19 which are listed for use for the particular application.

# PART 3 - EXECUTION

#### 3.1 INSPECTION

A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

## 3.2 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Install electrical connections as indicated, in accordance with equipment manufacturer's written instructions, with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA's "Standard of Installation" to ensure that products fulfill requirements.
- B. Coordinate with other work, including wires/cables, raceway, and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors

of electrical connection for proper interface between electrical power supplies and installed equipment.

- D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating than, electrical insulation rating of those conductors being spliced.
- E. Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
- F. Trim cables and wires as short as practical and arrange routing to facilitate inspection, testing and maintenance.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torqueing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.
- H. Fasten identification markers to each electrical power supply wire/cable conductor in accordance with Division 26 Section "Electrical Identification". Affix markers on each terminal conductor as close as possible to the point of connection.

# 3.3 CONNECTIONS TO MOTORS

- A. Make electrical connections to all motors, appliances, and other equipment and associated control devices in accordance with the schedules on the drawings and as hereinafter specified.
  - 1. In each case, verify connections and physical data from approved shop drawing, manufacturer's wiring diagrams, and/or detail drawings provided by relevant trade subcontractor.
  - 2. Generally, all motors and equipment will be furnished and set in place by others, and the electrical contractor shall make all connections thereto. Where indicated in schedules and specified, this contractor shall furnish and install starter, manual controls, and auxiliary equipment. This contractor shall furnish and install all disconnect switches required by code.
- B. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration. Flexible conduit connections shall be not less than 12" no more than 18".
- C. When connecting adjustable speed drives (ASDs) to a motor, install the conductors from the drive to the motor in a separate raceway. Installing conductors in a common conduit or wireway is not acceptable.

## 3.4 CONNECTIONS TO TEMPERATURE CONTROL EQUIPMENT

A. Make electrical connections to temperature control equipment as indicated in the plans and specifications and according to the manufacturer's written instruction. Coordinate with the mechanical contractor.

## 3.5 CONNECTIONS TO ELEVATOR

- A. Provide smoke detectors in elevator shaft, each elevator lobby, and equipment room to initiate Phase I emergency recall upon activation of detectors.
- B. Power for machine room lights and receptacles shall be on separate branch circuit.
- C. Power for hoistway pit lights and receptacles shall be on separate branch circuit.
- D. Receptacles in hoistway pit and machine room shall be GFCI type.
- E. Lighting in hoistway pit and machine room shall not be connected to the load side of the GFCI receptacle in the space.
- F. Provide 15 ampere lockable, fused disconnect switch for elevator cab light and power.
- G. Verify location of all equipment in pit, shaft and machine room with elevator contractor.

#### 3.6 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site; then retest to demonstrate compliance.

# SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

#### 1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

## 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 DEVICES

- A. Outdoor Photoelectric Switches: Solid state, with DPST dry contacts rated for 1800-VA tungsten, to operate connected relay, contactor coils, and microprocessor input; complying with UL 773A.
  - 1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
  - 2. Time Delay: 15-second minimum.
  - 3. Surge Protection: Metal-oxide varistor.
- B. Indoor, Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit complying with UL 773A, with separate relay unit rated for 20-A ballast load at 120- and 277-V ac. Cadmium sulfide photoresistors are not acceptable.
  - 1. Type: Dual technology (passive infrared and ultrasonic).
  - 2. Voltage: 120/277 V.
  - 3. Switch Rating: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac.
  - 4. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
  - 5. Time Delay: Adjustable from 5 to 300 seconds.
  - 6. Set-Point Adjustment: With deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
  - 7. Indicator: Two LEDs.
- C. Indoor, Wall-Switch Occupancy Sensors:
  - 1. Type: Dual technology (passive infrared and ultrasonic).
  - 2. Voltage: 120/277 V.

- 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- 4. Time Delay: Adjustable up to 30 minutes. Confirm each sensor is set to maximum time delay at Substantial Completion.
- 5. Field of View: 180 degrees.
- 6. Minimum Coverage Area: 900 sq. ft.
- D. High Bay Occupancy Sensors:
  - 1. Type: Dual technology (passive infrared and ultrasonic).
  - 2. Voltage: 120/277 V.
  - 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
  - 4. Time Delay: Adjustable up to 30 minutes. Confirm each sensor is set to maximum time delay at Substantial Completion.
  - 5. Field of View: Aisle bi-directional or high bay 360 degrees based on installation location.
  - 6. Minimum Coverage Area: 900 sq. ft.
- E. Outdoor, Weatherproof Motion Sensors:
  - 1. Type: Passive infrared.
  - 2. Switch Rating:
    - a. Lighting-Fixture-Mounted Sensor: 500-VA fluorescent.
    - b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac.
  - 3. Voltage: 120/277 V.
  - 4. Time Delay: Adjustable up to 15 minutes.
  - 5. Detection Coverage: 180-degree field of view and 110-foot detection range.
- F. Lighting Contactors: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- C. Label time switches and contactors with a unique designation.
- D. Verify actuation of each sensor and adjust time delays.

## Vincennes University Green Activities Center Partial Renovations

E. Lighting control vendor shall provide for an on-site inspection by qualified manufacturer's representative to confirm proper controls installation & operation. This inspection shall be performed after Date of Substantial Completion, and shall be documented by vendor's written report to Engineer.
## SECTION 260924 – SPECIALTY LIGHTING CONTROL

PART 1 - GENERAL

## 1.1 WORK INCLUDED

- A. Electrical Contractor shall provide for complete lighting control system fully operational including devices & wiring, as shown on construction drawings & specified herein.
- B. Lighting control vendor shall provide for an on-site inspection by qualified manufacturer's representative to confirm proper controls installation & operation. This inspection shall be performed after Date of Substantial Completion, and shall be documented by vendor's written report to Engineer.
- C. Lighting control vendor shall provide for (1) 4-hour training session for Owner's representatives.

Project	Catalog #	Туре	
Prepared by	Notes	Date	



# IL Area Controllers

Modular design control panels with digital, 0-10V dimming, relay modules, bridge interface and ethernet gateway.

#### **Typical Applications**

Office • Education • Healthcare • Hospitality • Retail • Industrial • Manufacturing • Outdoor

# Interactive Menu

- Order Information page 2
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- SCMH1200-NA page 5
- SCMD4-NA page 6
- EG2-S-NA page 7
- Connected Systems page 8
- Product Warranty

# **Top Product Features**

- Modular design with digital, relay and dimming modules providing the flexibility and scalability neded to support all size and types of applications
- Factory assembled and pre-wired module ready to be installed by the electrical contractor with minimal wiring and eliminating non-value added on-site panel assembly and wire termination work
- LED diagnostics indicators and built-in override buttons to easily test, commission and troubleshoot the system
- Built-in interface modules for DMX, A/V and shades integration
- · Mix and match digital control devices with digital, phase and 0-10V dimmable loads

# Dimensional Details





## **Product Features**

**Product Certification** 



25-5/32" [639mm

# **Order Information**

#### Catalog Number

Catalog Number <sup>(1)</sup>	Panel Size	SCMR1220-NA	SCMH1200-NA	SCMD4-NA	EG2-S-NA
ILS-0001		0	0	0	1
ILS-0002		0	0	0	2
ILS-0010		0	0	1	0
ILS-0011		0	0	1	1
ILS-0020		0	0	2	0
ILS-0200	0	0	2	0	0
ILS-1000	Smail	1	0	0	0
ILS-1001		1	0	0	1
ILS-1010		1	0	1	0
ILS-1011		1	0	1	1
ILS-1100		1	1	0	0
ILS-2000		2	0	0	0
ILM 1111		1	1	1	1
ILM-0010		0	0	1	0
ILM-0021		0	0	2	1
ILM-0031		0	0	3	1
ILM-0040		0	0	4	0
ILM-0041		0	0	4	1
ILM-1011		1	0	1	1
ILM-1031		1	0	3	1
ILM-1101		1	1	0	1
ILM-1110		1	1	1	0
ILM-1121		1	1	2	1
ILM-2001	Medium	2	0	0	1
ILM-2110	·	2	1	1	0
ILM-2111		2	1	1	1
ILM-2200		2	2	0	0
ILM-2201		2	2	0	1
ILM-2210		2	2	1	0
ILM-2211		2	2	1	1
ILM-3000		3	0	0	0
ILM-3001		3	0	0	1
ILM-3011		3	0	1	1
ILM-3100		3	1	0	0
ILM-4000		4	0	0	0
ILM-4001		4	0	0	1
ILL-0051		0	0	5	1
ILL-0061		0	0	6	1
ILL-2131		2	1	3	1
ILL-2210		2	2	1	0
ILL-2211		2	2	1	1
ILL-2321		2	3	2	1
ILL-3200	Large	3	2	U	U
ILL-3300		3	3	U	1
ILL-3301		3	3	1	1
11.4400		3	3	۱ ۸	۱ ۸
ILL 4400		4	4	n	1
IL 4401		4	4	1	n
III.4410		4	4	1	1
122.4411		4 No	4 tes	1	1

Notes
All medium and large size panel catalog numbers are available without bridge network module installed by default. To order, add -BN0 to end of the existing catalog number. For example: ILM-2200-BN0.



# **IL Area Controllers Product Specifications**

#### Key Features

- UL listed Ensures code compliance with the local electrical code
- DALI 2 certified SCMD4 module Each SCMD4 module offers 4 wired local buses
   used to manage 64 digital devices
- Supports various ballast/driver types controllable by 0-10V
- Supports up to 48 switched outputs (based on selected configuration)
- Heavy duty 20A (@ 40C) relays used on all relay modules
- Capable of providing versatile solutions that include relays outputs, 0-10V outputs, DMX inputs and WaveLinx wired local bus connections for controls inputs and luminaire level local control
- Capable of mixed load voltages (120/277 VAC 50/60Hz) based on proper spacing and wire insulation.
- Panel systems solutions include both normal and emergency power sources based on proper spacing and wire insulation
- Ethernet connectivity available (based on selected catalog number)
- Capable of meeting all latest energy codes (IECC, Title 24, ASHRAE)

#### Mechanical

Enclosure: NEMA 1, Surface Mount, lockable, Size: See Dimensions Enclosure Size:

- Small: 14.56" W X 12.22" H X 3.56" D (369.8mm x 310.4mm x 90.4mm)
- Medium: 25.67" W X 25.34" H X 6.06" D (652mm x 643.6mm x 153.9mm)
- Large: 25.73" W X 35.54" H X 6.07" D (653.5mm x 902.7mm x 154.2mm) Weight:

weight.

- Small: 10lbs (4.5 kg)
- Medium: 33lbs (15 kg)
- Large: 59lbs (26.7 kg)

#### Environment:

- **Operating temperature:** 35°F to 122°F (+2° C to +50° C)
- Max Storage temperature: 140°F (+60° C)
- Relative humidity operating: +5 to 95% non-condensing
- For indoor use only

#### Electrical

Supply: 120-277VAC ± 10% 50/60Hz, 5A Max

#### Maximum Load:

- Switching Load: 20A max. per relay, 192A max. total (SCMR1220 Module)
- 0-10V Load: 50mA per channel (SCMH1200 Module)
- Local buses: 250mA per loop/bus (SCMD4 Module)
- Protection Internal: 5A Circuit Breaker for incoming power

WaveLinx Wired Network: Use Belden 1502 or 1502P, WaveLinx wired accessory LCCP or LCCNP or equal

Local Bus Wiring: 18-14AWG (depending on distance)

**0-10V Wiring:** 18-14AWG (depending on distance)

#### Standards/Ratings

- cULus Listed Energy Management Equipment (UL916)
- Meets ASHRAE Standard 90.1 requirements
- Meets IECC 2015 requirements
- Meets CEC Title 24 requirements

Environmental Regulations:

NEMA 1 Type 1

#### Warranty

Five year warranty standard

## **Overview**

Cooper Lighting Solutions WaveLinx wired area controllers are one single lighting control solution for all traditional wired control application needs. Designed to be the most scalable, simple, modular and feature rich, these DIN Rail based lighting area controllers are capable of handling energy management, code compliance, architectural lighting and individual addressable lighting applications, all from a single system.

The Cooper Lighting Solutions WaveLinx wired IL area controllers are sold as a portfolio of feature rich lighting control panels that come in 20 different base configurations across three different enclosure sizes- small, medium and large. All configurations in medium and large size enclosures have the Ethernet Gateway (EG2-S-NA) available as an option. Each configuration and option combination has a unique catalog number (within the IL Series) for ease of ordering and identification.

Depending upon the size of the job and the limitations of the electrical closet and/or equipment room spaces, the area controllers can be mixed and matched and networked together. Each area controller configuration is fully networkable via Cooper Lighting Solutions WaveLinx wired network and commissioned via the Device Editor software package.

The WaveLinx wired area controller series solution comes compatible with a full complement of Cooper Lighting Solutions existing portfolio of sensors and accessories. These can be configured with any of the IL Series area controller configurations to create a powerful lighting control solution that can perform a variety of functions such as:

- Occupancy/Vacancy sensing
- Scheduling
- Daylight Harvesting
- Shade Control
- A/V Integration
- Standard/Custom partitioning
- DMX control
- BMS integration and more. Please refer to the design guide and product brochure for more details



# SCMR1220-NA

# SCMR1220-NA

12 Channel 20 AMP Feed through Relay control module

# **Top Product Features**

- 12 x 20A Mechanically held feed through relays
- Supports multiple phases
- Switches resistive, inductive and capacitive lighting loads
- · Build in relay sequence delay to avoid large inrush
- Manual override per relay
- · Alarm and Emergency input
- Mounts to standard Top Hat (TS35) DINRail
- Intelligent 'Built in' propagation delay for switching sequence 1-12
- RS485 / DMX512 input with DMX base address rotary switches
- 2 x Auxiliary Inputs

# Dimensions



## **Overview**

The SCMR1220-NA relay control module is a 12 channel 20A feed through relay unit that provides outstanding features and performance in a truly competitive and compact package. Each channel is rated for up to 20A and is designed to switch heavy loads of all types.

With a digital network, DMX and DALI connectivity, it has the capability of being linked with a virtually limitless number of other WaveLinx wired products to build up to any size of system. This product is designed for projects where high power switching is required including LED's, fluorescents as well as non-lighting loads of any voltage up to 277VAC.

# SCMR1220-NA Product Specifications

#### Mechanical

Weight: 0.8kg, 1.7637lbs Operating temperature: +2°C to +50°C Note: All enclosures must be adequately ventilated Max storage temperature: +60°C Humidity: +5 to 95% non-condensing Environmental protection: IP20

#### Electrical

Control: Via digital network connection, DMX or DALI Supply: 120-277VAC -/+ 10% 50/60HZ, 0.1A MAX Integral iCANnetTM Network Power Supply: 15V 500mA Output channel current: Maximum 20A at 40°C (Total unit load not to exceed 192A) Note: Fully loaded channels should be spaced every other channel to prevent heat buildup Relay outputs: Capable of switching capacitive inductive or resistive loads Loads - maximum cable size: 12AWG per circuit

Protection: Provided by installer - use supply MCB, 6A or less

#### Standards/Ratings

- cULus Listed Energy Management Equipment (UL916)
- Manufactured in an ISO 9001 certified factory
- Meets ASHRAE Standard 90.1 requirements
- Meets IECC 2015 requirements
- Meets CEC Title 24 requirements
- Environmental Regulations:
  - RoHS Directive 2011/65/EU

### Warranty

Five year warranty standard



# SCMH1200-NA

# SCMH1200-NA

12 Channel 0-10V Dimming Control Module

# **Top Product Features**

- Twelve channel device
- 1-10V, 0-10V
- 128 scene memory
- Connects to WaveLinx digital network
- Fail to full bright safety feature

## **Overview**

The SCMH1200-NA is a DINRail mount 12 channel 0-10V control module. Each channel may be configured to provide 1-10V or 0-10V control for analog devices. With WaveLinx wired network connectivity, it has the capability of being linked with a virtually limitless number of other WaveLinx wired products to build any size of system.



# SCMH1200-NA Product Specifications

#### Mechanical

### Weight: 0.35kg/0.77lbs

**Operating temperature:** +2°C to +50°C

Note: All enclosures must be adequately ventilated Max storage temperature: +60°C

Humidity: +5 to 95% non-condensing Environmental protection: IP20

#### **Electrical**

Control: Via digital network connection or DALI Supply: 120-277VAC -/+ 10% 50/60 Hz, 0.3AMAX

#### Load Types:

- 80 per channel do not exceed 500 drivers or ballasts in total
- 0-10V control, 50mA source current
- 1-10V control, 50mA sink current

#### **Terminal Sizes:**

- · Incoming supply, max cable size: 16 AWG
- 0-10V output, max cable size: 16 AWG per terminal
- Digital network cable type: Belden 1502 or equivalent

#### Standards/Ratings

**Dimensions** 

- cULus Listed Energy Management Equipment (UL916)
- Manufactured in an ISO 9001 certified factory
- Meets ASHRAE Standard 90.1 requirements
- Meets IECC 2015 requirements
- Meets CEC Title 24 requirements Environmental Regulations:

RoHS Directive 2011/65/EU

#### Warranty

Five year warranty standard



# EG2-S-NA

## **Ethernet Gateway**

## **Top Product Features**

- Connects WaveLinx Wired iCANnet<sup>™</sup> network to 10/100 Mbps Ethernet LAN
- Configurable IP address
- Scheduled events with time clock supporting multiple time zones, regional daylight savings and NTP if required.
- iCAN network bridging over IP
- Supports iCANSoft suite of applications and Trellix
- Power from PSU or iCANnet<sup>™</sup> Network
- Status LEDs

## **Overview**

The EG2-S-NA provides Ethernet connectivity to the iCAN network for integration into our software services as well as providing API integration for third-party systems.

The EG2-S-NA incorporates an intelligent bridge function which allows multiple systems to be joined over a secure Ethernet network opening up the capabilities of the iCAN system to cover multi-campus installations across the globe giving building and business owners connectivity to there systems from anywhere in the world

# **Dimensions**

# front





# EG2-S-NA Product Specifications

#### Mechanical

Size: 4.17" x 3.58" x 2.44" (106mm x 91mm x 62mm) Weight: 0.49 lbs (0.22 kg) Environment:

- Operating temperature: 35°F to 122°F (+2°C to +50°C)
- Max storage temperature: 0°F to 0°F (+60°C)
- Ambient temperature: 0°F to 0°F (+2°C to +50°C)
- · Relative humidity: 5% 95% max, non-condensing

IP rating: IP20

#### Electrical

Control: Via iLight network connection

Supply: +10 - 24V DC @ 750 mA Max via external power supply or from iCANnet™ Terminal Size: iCANnet<sup>™</sup> cable size: 5 x 1mm<sup>2</sup> Power cable size: 2 x 1mm<sup>2</sup> Protection: Fully transformer isolated ethernet

#### **Software Specifications**

Programming: For programming EG2-S, Device Editor software is required

#### Standards/Ratings

- cULus Listed Energy Management Equipment (UL916)
- · Manufactured in an ISO 9001 certified factory
- Meets ASHRAE Standard 90.1 requirements
- Meets IECC 2015 requirements
- Meets CEC Title 24 requirements
- · Designed and manufactured to ISO9001 standards

#### Warranty

Five year warranty standard



# EG2-S-N

# System architecture

Simple WaveLinx wired system





Complete WaveLinx wired system





# **Area Controllers**

View

WaveLinx Pro Network

and IT Guidance

**Technical Guide** 

# Sample System Topology:

This diagram shows the main components of the WaveLinx wired and Pro wireless connected lighting system.

The WaveLinx Pro wireless system communicates using wireless mesh technology based on the IEEE 802.15.4 standard. A PoE LAN connection for each Wireless Area Controller (WAC) is required for power and data access to the building lighting network. The WaveLinx wired system controls the devices using relay, 0-10V, DMX and the WaveLinx wired digital local bus. The WaveLinx wired system connects to the building LAN using the EG2-S-NA module. Each WaveLinx wired area controller communicates on the WaveLinx wired network.

WaveLinx Pro Wireless Area Controllers (WAC) and WaveLinx Ethernet Gateways (EG2-S-NA) communicate with Trellix over the Ethernet network.

Please refer to the WaveLinx Pro Wireless Network and IT Guidance Technical Guide and WaveLinx Wired Network and IT Guidance Technical Guide for more information.



# Control Systems

- Trellix
- WaveLinx Pro wireless
- WaveLinx wired
- VividTune



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Specifications and dimensions subject to change without notice.

Project	Catalog #	Туре	
Prepared by	Notes	Date	



TSI-1-NA

**TSE Touchscreen Interface** 

### **Typical Applications**

**Product Features** 

Office • Education • Healthcare • Hospitality • Retail

# 🖌 Interactive Menu

- Order Information page 2
- Additional Resources page 3
- Wiring Diagrams page 3
- Connected Systems page 5
- Product Warranty

# **Top Product Features**

- Connects WaveLinx Wired TSE55-B and TSE80-B touchscreens to the WaveLinx Wired network
- · Connects multiple TSE screens and mobile devices running the TSEtouch app
- Configurable IP address.
- Built-in timeclock for scheduled events
- Supports smart device applications (iPhone®/ iPod touch®/ iPad® / Android)
- BACnet communication over TCP/IP
- · CE compliant to all relevant standards
- Designed and manufactured to ISO 9001:2015 standards

# **Dimensional Details**









## **Order Information**

Catalog Number

Catalog Number	Description
TSI-1-NA	Touchscreen interface accessory

## **Product Specifications**

#### **Key Features**

- TSI-1-NA Touchscreen Interface enables the use of multiple TSE55-B and TSE80-B color touchscreens
- Ensures synchronization of screen configurations across an entire building installation
- Facilitates connection to WaveLinx Wired TSEtouch app enabling personalized control from your compatible hand held smart device
- A built in scheduler allows for timed events to suit your building needs and BACnet capabilities for the integration of building services such as HVAC, further enhancing the capabilities of this powerful interface unit
- Can be operated as a standalone unit for timeclock functionality or with a TSE Touchscreen. If operated as a standalone unit, schedules are edited via the WaveLinx Wired Configuration software suite.

#### Mechanical

Enclosure Size: 4.17w" x 3.58h" x 2.44d" (106mm x 91mm x 62mm) Weight: 0.49 lbs (0.22 kg)

Environment:

- Operating temperature: 35°F to 122°F (2°C to 50°C)
- · Humidity: +5 to 95% non-condensing
- · Note: All enclosures must be adequately ventilated

#### Electrical

#### Supply:

Supply: +10 - 24V DC @ 750 mA Max (via external power supply)

#### Standards/Ratings

Environmental Regulations: • IP20

#### Warranty

Five year warranty standard



# System architecture

Simple WaveLinx Wired system



Complete WaveLinx Wired system





# **Typical schematic**





# **Touchscreen Interface**

View

WaveLinx Pro Network

and IT Guidance

**Technical Guide** 

# Sample System Topology:

This diagram shows the main components of the WaveLinx wired and Pro wireless connected lighting system.

The **WaveLinx Pro wireless system** communicates using wireless mesh technology based on the IEEE 802.15.4 standard. A PoE LAN connection for each Wireless Area Controller (WAC) is required for power and data access to the building lighting network. The **WaveLinx wired system** controls the devices using relay, 0-10V, DMX and the WaveLinx wired digital local bus. The WaveLinx wired system connects to the building LAN using the EG2-S-NA module. Each WaveLinx wired area controller communicates on the WaveLinx wired network.

WaveLinx Pro Wireless Area Controllers (WAC) and WaveLinx Ethernet Gateways (EG2-S-NA) communicate with Trellix over the Ethernet network.

Please refer to the WaveLinx Pro Wireless Network and IT Guidance Technical Guide and WaveLinx Wired Network and IT Guidance Technical Guide for more information.



# 

- Trellix
- WaveLinx Pro wireless
- WaveLinx wired
- VividTune



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Specifications and dimensions subject to change without notice.

Project	Catalog #	Туре	
Prepared by	Notes	Date	



# Interactive Menu

- Order Information page 2
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- Product Warranty

# WaveLinx Pro

# 8-4 POE Ports Unmanaged Network Switch

The 8-4 POE Ports unmanaged network switch (GS308P-100NAS) provides power and data from a single Ethernet (CAT-5e) cable to devices such as WaveLinx Pro Wireless Area Controller and WaveLinx Pro Touchscreen

**Typical Applications** Office • Education • Healthcare

# Product Certification



# **Product Features**



# **Top Product Features**

- 802.3af Power Over Ethernet (PoE) Allowing the user to power up to four (4) WaveLinx Pro Wireless Area Controllers and/or WaveLinx Pro Touchscreen
- Auto-MDI/MDIX Eliminates the need for crossover cables
- · LED indicators Allowing user to easily set the status of each port
- Fan-less design Ensuring silent operation of the switch
- Plug-and-play No setup required

# **Dimensional Details**





# **Order Information**

#### Catalog Number

Catalog Number	Description
GS308P-100NAS	Netgear GS308P-100NAS POE Switch

#### Required Accessories

All WaveLinx Pro connected lighting (WCL) system accessories require at least one WaveLinx Pro Wireless Area Controller (WAC2) for communications. Ensure the bill of material includes one of the following components.

#### Catalog Number

Catalog Number	Description
WAC2-POE	Wireless Area Controller G2, PoE powered
WAC2-120	Wireless Area Controller G2 with 120VAC to PoE Injector

# **Product Specifications**

#### Key Features

- Unmanaged
- Auto-MDI/MDIX
- Fanless
- Plug-and-play

#### Mechanical

Size: 6.2" W x 4.0" D x 1.1" H (158mm x 101mm x 29mm) Weight: 1.02 lbs (0.46 kg)

#### Environment:

- Operating temperature: 32°F to 104°F (0°C to 40°C)
  - Storage temperature: -4°F to 158°F (-20°C to 70°C)
  - · Operating/ Storage Humidity: 90% maximum relative humidity (RH),
  - non-condensing / 95% maximum relative humidity (RH), non-condensing • For indoor use only
- Mounting: Desktop or wall-mountable

Housing: Metal

## Connector Type: Metal

#### Electrical

- Power Consumption
- DC Input/Power In: 48V, 1.25A
- Power Consumption (Max and Standby): 60W/0.28W
- Heat Dissipation (Max and Standby) (BUT/Hr): 205.20 BTU/0.96 BTU

#### **Hardware Specifications**

#### LEDs

- Per Port: Speed, Link/Activity (Left), Ports 1-4: PoE Power (Right)
- Per Device: Power, PoE Max

#### **Performance Specifications**

- · Bandwidth (Non-Blocking): 16 Gbps
- Packet Buffer Memory (Dynamically shared across only used ports): 192 KB
- · Jumbo Frame Support: 9,720 bytes
- · Queue WRR (Weighted Round Robin): 1:2:4:8
- Forwarding Rate (using 64-byte packets): 1,448,000 pps
- Latency (using 64-byte packets): < 3.0 µsec
- MAC Address Table Size: 4K
- · Auto MDI/MDI-X Cable Detection: Yes
- Auto-sensing Half/Full Duplex Switched Ports: Yes
- · Mean Time Between Failures (MTBF) @ 25° C : 2,244,211 hours

#### Quality of Service (QoS)

- · 802.1P Based (CoS) Supported: Yes
- Honors DSCP (DiffServ) Tags: No

#### PoE Configuration

- · 802.3af PoE Ports: Ports 1-4
- PoE Max Power Per Port: Up to 15.4W
- Total PoE Power Budget: Up to 53W
- PoE auto-balance: No

#### **Energy Efficiency**

- · Energy Efficient Ethernet (EEE) IEEE 802.3AZ: Yes
- · Auto Power Down: Yes
- · Short Cable Detection: Yes
- Fan/Fanless: Fanless

#### Standards/Ratings

- FCC Part 15/ECES-003
- IC Class A
- IEEE Network Protocols
- · IEEE 802.3ab 1000BASE-T Gigabit Ethernet
- · IEEE 802.3u 100BASE-TX Fast Ethernet
- · IEEE 802.3i 10BASE-T Ethernet
- IEEE 802.3x Flow Control
- IEEE 802.1p Priority QoS (all models)
- · IEEE 802.3 CSMA/CD
- 802.3az Energy Efficient Ethernet

#### Environmental Regulations:

Electromagnetic Emissions and Immunity

#### Warranty

Three year warranty



# **WaveLinx Pro**

## Installation

- Step 1: Install the switch on the rack or a wall. The PoE Switch is usually mounted in an electrical or telecom room
- Step 2: Connect equipment to using Category 5 or Category 6 cable with terminated RJ-45 connectors.
- Connect PoE devices (WACs or Touchscreens) to ports marked "PoE Ports"
- Step 3: Connect power adapter to back of switch and plug adapter into 120V AC outlet
- Step 4: Check status lights as shown. AVDC OAA



# **System Architecture**

This diagram shows the main components of the WaveLinx Pro wireless connected lighting system. The IP devices, i.e. WaveLinx Pro Wireless Area Controllers (WACs), WaveLinx Pro Touchscreen, WaveLinx Pro Low-Voltage Power Modules and Trellix Core appliances communicate over a dedicated Local Area Network or Virtual Local Area Controller. The network switch can be provided either by the customer or the GS308P switch can be used to provide network connectivity between devices.

View WaveLinx Pro Network and IT Guidance Technical Guide





# **WaveLinx Pro**

# **Unmanaged Network Switch**

## Better Data. Better Decisions.

Trellix combined with our WaveLinx Pro connected lighting system is a distributed network of LED lighting fixtures with integrated sensing and beacon technology that captures real-time data; making your facility smarter so you can make smarter decisions.

Trellix provides an open IoT platform and infrastructure that connects intelligent sensors leveraging the real-estate of the physical light fixture to solve higher complexity problems in a commercial building to deliver actionable insights through the aggregation of valuable data.



# Control Systems

- Trellix
- WaveLinx Pro wireless



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Project	Catalog #	Туре	
Prepared by	Notes	Date	



# TSE55-B

5.5" LCD Color Touchscreen

### **Typical Applications**

Office • Education • Healthcare • Hospitality • Retail

# 🖌 Interactive Menu

- Order Information page 2
- Additional Resources page 3
- Wiring Diagrams page 3
- Connected Systems page 5
- Product Warranty

# **Top Product Features**

- PoE touchscreen can be installed virtually anywhere
- Customizable graphics
- Password protection capabilities
- · Area, Scene, Zone level control with buttons and/or sliders
- · Save scene capabilities with password protection
- Color picker for white tuning or DMX color changing

# **Dimensional and Mounting Details**



5.5" touchscreen is installed in a standard single gang box opening, either portrait or landscape.



Scale





# Product Features



# **Order Information**

Catalog Number

Catalog Number	Description		
TSE55-B	5.5" LED color touchscreen, Black		

#### **Required Accessories**

#### Catalog Number

Catalog Number	Description		
TSI-1-NA	Touchscreen interface accessory		

# **Product Specifications**

#### **Key Features**

- 5.5 inch (140mm) diagonal backlit capacitive LCD touchscreen
- 1280 X 720 pixel resolution
- Color Depth: 16.7M colours, 450 nits brightness
- Ambient Light sensor
- Fits standard single gang backbox (35mm depth)
- All graphics and buttons can be customized
- · Password feature to allow different access levels
- Designed and manufactured to ISO9001:2015 standards
- Portrait or landscape mounting and layout

#### Functionality

#### Scene Selection

- Scene programming
- Channel level indicated with bar graphs and percentage
- Scene and channel naming
- Default screen programming
- Photocell / motion sensor interaction
- Ability to import drawings, customer logos and images as background graphics
- Ability to insert soft buttons for activating scenes and / or channels

#### Mechanical

**Display:** High performance HD, IPS 5.5" LCD, 1280 X 720 resolution **Color Depth:** 

16.7M colors, 450 nits brightness

- Client Range:
  - Temperature: +2°C to +40°C
  - Humidity: +5 to 95% non condensing

### Electrical

Supply:

 PoE 802.3af complaint or via 24-57Vdc power connector on the rear Power Connection:

### • RJ45

### Programming:

Cooper's Touchscreen Designer software via Ethernet connection
Diagnostics:

network

Memory:

1GB DDR3

• 8GB eMMc

#### Standards/Ratings

- cULus Listed Energy Management Equipment (UL916)
- FCC Part 15/ECES-003
- Manufactured in an ISO 9001 certified factory
- Meets ASHRAE Standard 90.1 requirements
- Meets CEC Title 24 requirements

#### **Product Safety:**

- IEC 60950-1
- UL 60950-1
- EN 60950-1
- CAN/CSA-C22.2 No. 60950-1

#### **Environmental Regulations:**

- RoHS Directive 2011/65/EU
- WEEE Directive 2012/19/EU

#### Warranty

Five year warranty standard



# System architecture

Simple WaveLinx Wired system



Complete WaveLinx Wired system





# **Typical schematic**



# Mounting



\*Images are examples for reference only.



# **TSE55-B Touchscreen**

View

WaveLinx Network

and IT Guidance

**Technical Guide** 

## Sample System Topology:

This diagram shows the main components of the WaveLinx Wireless and Wired Connected Lighting system.

The **WaveLinx wireless system** communicates using wireless mesh technology based on the IEEE 802.15.4 standard. A PoE LAN connection for each Wireless Area Controller (WAC) is required for power and data access to the building lighting network. The **WaveLinx wired system** controls the devices using relay, 0-10V, DMX and the WaveLinx wired digital local bus. The WaveLinx wired system connects to the building LAN using the EG2 module. Each WaveLinx wired area controller communicate on the WaveLinx wired network. The WaveLinx wired network. The WaveLinx wired network.

The Trellix Core, WaveLinx Area Controllers (WAC) and WaveLinx Ethernet Gateways (EG2) communicate with each other over the Ethernet network.

Please refer to the WaveLinx Wireless Network and IT Guidance Technical Guide and WaveLinx Wired Network and IT Guidance Technical Guide for more information.



# Control Systems

- Trellix
- WaveLinx Wireless
- WaveLinx Wired
- VividTune



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## SECTION 262416 - PANELBOARDS

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Lighting and appliance panelboards.
- B. Load centers.
- C. Overcurrent protective devices for panelboards.

## 1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.

## 1.3 REFERENCE STANDARDS

- A. FS W-C-375 Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision D, 2006.
- B. NECA 1 Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- C. NECA 407 Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.
- D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- E. NEMA PB 1 Panelboards; National Electrical Manufacturers Association; 2006.
- F. NEMA PB 1.1 General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2007.
- G. NETA STD ATS Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2009.
- H. NFPA 70 National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- I. UL 50 Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 67 Panelboards; Current Edition, Including All Revisions.
- L. UL 489 Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- M. UL 869A Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- N. UL 943 Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- O. UL 1699 Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

## 1.4 ADMINISTRATIVE REQUIREMENTS

## A. Coordination:

- 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
- 3. Coordinate the work with other trades to provide walls suitable for installation of flushmounted panelboards where indicated.
- 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
- 5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

## 1.5 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
  - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
  - 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

- D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 60 00 Product Requirements, for additional provisions.
  - 2. Panelboard Keys: Two of each different key.

## 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- 1.7 DELIVERY, STORAGE, AND HANDLING
  - A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
  - B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
  - C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

## 1.8 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
  - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Siemens Industry, Inc: <u>www.sea.siemens.com</u>.
- B. Eaton Corporation; Cutler-Hammer Products: <u>www.eaton.com</u>.
- C. General Electric Company: <u>www.geindustrial.com</u>.
- D. Schneider Electric; Square D Products: <u>www.schneider-electric.us</u>.
- E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

### 2.2 ALL PANELBOARDS

- A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
  - 1. Altitude: Less than 6,600 feet.
  - 2. Ambient Temperature:
    - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
  - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings. (22,000 AIC)
  - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
  - 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
  - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
  - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
  - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
    - a. Indoor Clean, Dry Locations: Type 1.
  - 2. Boxes: Galvanized steel unless otherwise indicated.
    - a. Provide wiring gutters sized to accommodate the conductors to be installed.
    - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
  - 3. Fronts:
    - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

- b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
- c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
- 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.
- L. Provide the following features and accessories where indicated or where required to complete installation:
  - 1. Feed-through lugs.
  - 2. Sub-feed lugs.

## 2.3 LIGHTING AND APPLIANCE PANELBOARDS (HOUSE PANELS)

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
  - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
  - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
  - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
  - 2. Phase and Neutral Bus Material: Aluminum.
  - 3. Ground Bus Material: Aluminum.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
  - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
  - 2. Provide clear plastic circuit directory holder mounted on inside of door.

## 2.4 LOAD CENTERS

- A. Description: Circuit breaker type load centers listed and labeled as complying with UL 67; ratings, configurations, and features as indicated on the drawings.
- B. Bussing:

- 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
- 2. Bus Material: Aluminum or copper.
- C. Circuit Breakers: Thermal magnetic plug-in type.
- D. Enclosures:
  - 1. Provide flush-mounted enclosures unless otherwise indicated.
  - 2. Fronts: Provide hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
  - 3. Provide circuit directory label on inside of door or individual circuit labels adjacent to circuit breakers.

## 2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
  - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
  - 2. Interrupting Capacity:
    - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
    - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
    - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
  - 3. Conductor Terminations:
    - a. Provide mechanical lugs unless otherwise indicated.
    - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
  - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
  - 5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
  - 6. Provide the following circuit breaker types where indicated.
    - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
    - b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
    - c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
    - d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.

- 7. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.
- 8. Do not use tandem circuit breakers.
- 9. Do not use handle ties in lieu of multi-pole circuit breakers.

## 2.6 SOURCE QUALITY CONTROL

A. Factory test panelboards according to NEMA PB 1.

## PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

## 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 05 29.
- E. Install panelboards plumb.
- F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- I. Provide grounding and bonding in accordance with Section 26 05 26.
- J. Install all field-installed branch devices, components, and accessories.

- K. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- L. Provide filler plates to cover unused spaces in panelboards.
- M. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
  - 1. Emergency and night lighting circuits.
  - 2. Fire detection and alarm circuits.
  - 3. Intrusion detection and access control system circuits.
  - 4. Video surveillance system circuits.
- N. Provide for replacement of (1) existing QOC4 42-pole panelboard door, with new lockable door, to match other, adjacent panelboard keying. Coordinate specific panelboard with Engineer.

## 3.3 FIELD QUALITY CONTROL

- A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect and test in accordance with NETA STD ATS, except Section 4.
- C. Test GFCI circuit breakers to verify proper operation.
- D. Test AFCI circuit breakers to verify proper operation.
- E. Correct deficiencies and replace damaged or defective panelboards or associated components.

### 3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

## 3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

## END OF SECTION 262416

## SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

- 1.1 SECTION INCLUDES
  - A. Wall switches.
  - B. Wall dimmers.
  - C. Receptacles.
  - D. Wall plates.
  - E. Floor box service fittings.

### 1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 Grounding and Bonding for Electrical Systems.
- B. Section 26 05 35 Surface Raceways: Surface raceway systems, including multi-outlet assemblies.
- C. Section 26 05 37 Boxes.
- D. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 09 23 Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors.
- F. Section 26 27 17 Equipment Wiring: Cords and plugs for equipment.

### 1.3 REFERENCE STANDARDS

- A. FS W-C-596 Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.
- B. FS W-S-896 Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
- C. NECA 1 Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- D. NEMA WD 1 General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).

- E. NEMA WD 6 Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).
- F. NFPA 70 National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 20 General-Use Snap Switches; Current Edition, Including All Revisions.
- H. UL 498 Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- I. UL 514D Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- J. UL 943 Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- K. UL 1472 Solid-State Dimming Controls; Current Edition, Including All Revisions.

## 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
  - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
  - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
  - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
  - 5. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
- B. Sequencing:
  - 1. Do not install wiring devices until final surface finishes and painting are complete.

## 1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- B. Operation and Maintenance Data:
  - 1. Wall Dimmers: Include information on operation and setting of presets.
  - 2. GFI Receptacles: Include information on status indicators and testing procedures and intervals.
- C. Project Record Documents: Record actual installed locations of wiring devices.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

- 1. See Section 01 60 00 Product Requirements, for additional provisions.
- 2. Extra Keys for Locking Switches: Two of each type.
- 3. Extra Wall Plates: Two of each style, size, and finish.

## 1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

## 1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Hubbell Incorporated: <u>www.hubbell-wiring.com</u>.
- B. Leviton Manufacturing Company, Inc: <u>www.leviton.com</u>.
- C. Pass & Seymour, a brand of Legrand North America, Inc: <u>www.legrand.us</u>
- D. Cooper Wiring Devices; <u>www.cooper.com</u>.
- E. Substitutions: See Section 01 60 00 Product Requirements.
- F. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer and obtained from a single supplier.

## 2.2 APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations. "GFI" not shown on all such receptacles on construction drawings, for clarity.
- D. Provide GFI protection for all receptacles installed within 6 feet of sinks. "GFI" not shown on all such receptacles on construction drawings, for clarity.
- E. Provide GFI protection for all receptacles installed in kitchens. "GFI" not shown on all such receptacles on construction drawings, for clarity.

- F. Provide GFI protection for all receptacles serving electric drinking fountains. "GFI" not shown on all such receptacles on construction drawings, for clarity.
- G. Unless noted otherwise, do not use combination switch/receptacle devices.
- H. For flush floor service fittings, use tile rings for installations in tile or carpet floors.

## 2.3 ALL WIRING DEVICES

A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

## B. Finishes:

- 1. All Wiring Devices: Gray with stainless steel wall plate unless otherwise indicated.
- 2. Wiring Devices Installed in Unfinished Spaces: Gray with stainless steel wall plate unless otherwise indicated.
- 3. Flush Floor Box Service Fittings: Gray wiring devices with stainless steel cover and ring/flange.

## 2.4 WALL SWITCHES

- A. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

	SINGLE POLE	TWO POLE	THREE WAY	FOUR WAY
Hubbell	No. HBL 1221	No. HBL 1222	No. HBL 1223	No. HBL 1224
Cooper	No. 2221	No. 2222	No. 2223	No. 2224
Leviton	No. 1221-2	No. 1222-2	No. 1223-2	No. 1224-2
Pass & Seymour	No. PS20AC-1	No. PS20AC-2	No. PS20AC-3	No. PS20AC-4

C. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

1.	Hubbell	No. HBL 1221PL
2.	Cooper	No. 2221PL
3.	Leviton	No. 1221-PL
4.	Pass & Seymour	No. PS20AC1-RPL
- D. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; all switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
  - 1. Hubbell No. HBL 1221L
  - 2. Cooper No. 2221L
  - 3. Leviton No. 1221-2L
  - 4. Pass & Seymour No. PS20AC1-L

## 2.5 WALL DIMMERS

### A. Manufacturers:

- 1. Leviton Manufacturing Company, Inc: <u>www.leviton.com</u>.
- 2. Lutron Electronics Company, Inc: <u>www.lutron.com</u>.
- 3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us
- 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. All Wall Dimmers: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C. Magnetic Low-Voltage Wall Dimmers: 120V AC, slide control type with separate on/off switch; single pole or three way as indicated on the drawings.
- D. Electronic Low-Voltage Wall Dimmers: 120V AC, slide control type with separate on/off switch; single pole or three way as indicated on the drawings.
- E. Fluorescent Wall Dimmers: 120 V AC, slide control type with separate on/off switch, compatible with dimming ballast controlled; single pole or three way as indicated on the drawings.
- F. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

### 2.6 RECEPTACLES

- A. Manufacturers:
  - 1. Hubbell Incorporated: <u>www.hubbell-wiring.com</u>.
  - 2. Leviton Manufacturing Company, Inc: <u>www.leviton.com</u>.
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: <u>www.legrand.us</u>
  - 4. Cooper Wiring Devices; <u>www.cooper.com</u>.
- B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.

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- 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
  - 1. Standard Convenience Receptacles: Commercial specification grade, 15A, 125V, NEMA 5-15R; single or duplex as indicated on the drawings.
  - 2. Dwelling Unit Convenience Receptacles: Commercial specification grade, 15A, 125V, NEMA 5-15R; single or duplex as indicated on the drawings.
  - 3. Provide 20A NEMA 5-20R in kitchens and all public / commercial spaces.
  - 4. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
  - 5. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
- D. GFI Receptacles:
  - 1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
    - a. Provide test and reset buttons of same color as device.
  - 2. Standard GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
  - 3. Weather Resistant GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

# 2.7 WALL PLATES

- A. Manufacturers:
  - 1. Hubbell Incorporated: <u>www.hubbell-wiring.com</u>.
  - 2. Leviton Manufacturing Company, Inc: <u>www.leviton.com</u>.
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: <u>www.legrand.us</u>.
  - 4. Cooper Wiring Devices; <u>www.cooper.com</u>.
  - 5. Substitutions: See Section 01 60 00 Product Requirements.
- B. All Wall Plates: Comply with UL 514D.
  - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
  - 2. Size: Standard.
  - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

- E. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- F. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected.

### 2.8 FLOOR BOX SERVICE FITTINGS

- A. Manufacturers:
  - 1. Hubbell Incorporated: <u>www.hubbell-wiring.com</u>.
  - 2. Thomas & Betts Corporation: <u>www.tnb.com</u>.
  - 3. Wiremold, a brand of Legrand North America, Inc: <u>www.legrand.us</u>
  - 4. Substitutions: See Section 01 60 00 Product Requirements.
- B. Description: Service fittings compatible with floor boxes provided under Section 26 05 37 with all components, adapters, and trims required for complete installation.
- C. Flush Floor Service Fittings:
  - 1. Single Service Flush Convenience Receptacles:
    - a. Cover: Rectangular.
    - b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
  - 2. Accessories:
    - a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
    - b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

### PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.

- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### 3.3 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.
- B. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
  - 1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
  - 2. Where multiple wall switches or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
  - 3. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.
  - 4. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- E. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- F. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- G. Unless otherwise indicated, GFI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFI protection.
- H. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.

- K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Identify wiring devices in accordance with Section 26 05 53.

# 3.4 FIELD QUALITY CONTROL

- A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch and wall dimmer with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

# 3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Engineer.

### 3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

### END OF SECTION 262726

# SECTION 262813 - FUSES

PART 1 - GENERAL

- 1.1 SECTION INCLUDES
  - A. Fuses.
  - B. Spare fuse cabinet.

### 1.2 RELATED REQUIREMENTS

- A. Section 26 05 53 Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 24 13 Switchboards: Fusible switches.

### 1.3 REFERENCE STANDARDS

- A. NEMA FU 1 Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; 2002 (R2007).
- B. UL 248-1 Low-Voltage Fuses Part 1: General Requirements; Current Edition, Including All Revisions.
- C. UL 248-8 Low-Voltage Fuses Part 8: Class J Fuses; Current Edition, Including All Revisions.
- D. UL 248-10 Low-Voltage Fuses Part 10: Class L Fuses; Current Edition, Including All Revisions.
- E. UL 248-12 Low-Voltage Fuses Part 12: Class R Fuses; Current Edition, Including All Revisions.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Cooper Bussmann, a division of Cooper Industries: www.cooperindustries.com.
- B. Mersen (formerly Ferraz Shawmut): ferrazshawmut.mersen.com.
- C. Littelfuse, Inc: www.littelfuse.com.
- D. Substitutions: See Section 01 60 00 Product Requirements.

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# 2.2 APPLICATIONS

# A. Service Entrance:

- 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay or Class J, time delay.
- 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.

# B. Feeders:

- 1. Fusible Switches from 70 Amperes up to 600 Amperes: Class RK1, time-delay or Class J, time delay.
- 2. Fusible Switches up to 60 Amperes: Class RK5, time-delay or Class J, time delay.
- 3. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- C. Individual Motor Branch Circuits: Class RK5, time-delay.

# 2.3 FUSES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
- H. Class J Fuses: Comply with UL 248-8.
- I. Class L Fuses: Comply with UL 248-10.

# 2.4 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.
- B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

# PART 3 - EXECUTION

# 3.1 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

# 3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where indicated.
- D. Identify spare fuse cabinet in accordance with Section 26 05 53.

#### END OF SECTION 262813

# SECTION 262815 – DISCONNECT SWITCHES

PART 1 - GENERAL

## 1.1 RELATED WORK

- A. Transformers.
- B. Secondary Grounding.

#### 1.2 INDUSTRY STANDARDS

- A. Equipment specified herein shall meet the applicable standards of the following agencies and associations.
  - 1. Underwriters' Laboratories, UL.
  - 2. Institute of Electrical and Electronic Engineers, IEEE.
  - 3. National Electrical Manufacturers Association, NEMA.

## 1.3 SUBMITTALS

- A. Furnish to the Architect shop drawings for the following items:
  - 1. Safety switches.
- B. All these items shall be by the same manufacturer as the switchboards and panel boards.

## PART 2 - PRODUCTS

#### 2.1 DISCONNECT SWITCHES

- A. Safety switches shall be heavy duty, fused unless noted otherwise, with number of poles, electrical characteristics, ratings and modifications as required. When used as service entrance equipment unit shall be labeled as such.
- B. Switching mechanism shall be quick-make, quick-break, with handle that is padlockable in the "Off" position.
- C. When safety switches are provided to control mechanical equipment it shall be Division 26 Contractor's responsibility to verify the number of poles needed and speed.
- D. Enclosure shall be suitable for the area in which it is to be installed and shall have a defeatable door interlock which prevents the door from opening when the switch is "on".

- E. Fusible units are to be equipped with current limiting fuses and shall have fuseholders with rejection clips to prevent other type fuses from being installed.
- F. Safety switches shall be as manufactured by Siemens, Square D, General Electric, Westinghouse or Cutler-Hammer.

## 2.2 FUSES

- A. Fuses shall be non-renewable with 200,000 amperes RMS symmetrical interrupting capacity.
  - 1. Class RK5 units shall be non-renewable, time-delay type:
    - a. Standards: Low-Peak; LPN-RK & LPS-RK - Bussman Co. Amp-Trap; TR-R and TRS-R - Gould-Shawmut Co. LON-RK and LOS-RK - CEFLO.
  - 2. Class L units.
    - a. Standards: LIMITRON; KRP-C - Bussman Co. AMP-TRAP; A4BY - Gould-Shawmut Co. CLL-CEFLO.
  - 3. Class J units.
    - a. Standards: Limitron; JKS - Bussman Co. Amp-Trap; A4J - Gould-Shawmut Co. CJS - CEFLO.
- B. Provide the Owner with 10% or three (3) spare fuses, whichever is greater, of each size and type used on the Project.

# PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Safety switches shall be installed where shown at 6' from floor to top of switch, unless otherwise noted.
- B. Install all items securely to walls, columns, or machine frames, and be responsible for all necessary brackets, mounting devices, structural pieces, anchors and/or inserts necessary for this purpose.
- C. Do not mount equipment directly to masonry or concrete walls. Provide a 3/4" plywood panel on the wall and securely mount equipment on the plywood. Approved alternate method of mounting equipment is mounting equipment on strut. Approved manufacturers are: B-Line, Kindorf/Superstrut, Unistrut or approved equal.

END OF SECTION 262816

#### **DISCONNECT SWITCHES**

# SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

#### 1.1 SECTION REQUIREMENTS

A. Submittals: Product Data.

### 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 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Fusible Switches, 600 A and Smaller: UL 98 and NEMA KS 1, Type HD, that accommodate specified fuses, and with lockable handle interlocked with cover in closed position.
- B. Nonfusible Switches, 600 A and Smaller: UL 98 and NEMA KS 1, Type HD, with lockable handle interlocked with cover in closed position.
- C. Shunt Trip Switches: Comply with UL 50, and UL 98, with 200-kA interrupting and shortcircuit current rating when fitted with Class J fuses.

## 2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Description: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with fieldadjustable instantaneous trip settings.
  - 3. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
  - 4. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
  - 5. GFEP Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
- B. Features and Accessories:
  - 1. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

### ENCLOSED SWITCHES AND CIRCUIT BREAKERS

2. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

### 2.4 ENCLOSURES

- A. NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  - 1. Outdoor Locations: NEMA 250, Type 3R.
  - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260500 "Common Work Results for Electrical."
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

#### 3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

END OF SECTION 262816

# SECTION 262923 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

A. Provide variable frequency drives (VFD) meeting the requirements contained herein and as indicated in the VFD schedule.

#### 1.2 QUALITY ASSURANCE

A. VFD shall comply with NFPA 70 (National Electrical Code), IEEE 519, UL 508, NFPA 70, and FCC compliance for Radio Frequency Interference (RFI) and Electro- Mechanical Interference (EMI).

### 1.3 WARRANTY

A. Provide a minimum of 3 years parts and labor warranty from the date of final acceptance by the County.

### 1.4 ACCEPTABLE MANUFACTURERS

A. Variable speed drives shall be manufactured by one of the following: Danfoss, Toshiba, ABB. VFDs manufactured by parent companies or their subsidiaries are not acceptable.

### 1.5 SUBMITTALS

- A. Submit for approval, the following product data:
  - 1. Dimensions and elevations.
  - 2. Complete product data listing all included features.
  - 3. The electrical rating for each VFD, matched to each piece of driven equipment.
  - 4. Fault current rating.
  - 5. Project specific wiring diagrams indicating:
    - a. Line/load connection points
    - b. Main input and inverter input disconnect switches
    - c. VFD/bypass switch circuit
    - d. Fusing/circuit breakers
    - e. Auxiliary control transformer
    - f. Local/remote circuit
    - g. Hand-off-auto circuit
    - h. Safety interlock, run permissive, and drive initiated external circuits
    - i. Analog inputs and outputs
    - j. Pilot lights

- k. Each wire on the wiring diagram shall be labeled with a distinct wire identifier.
- 6. VFD panel face diagram indicating the location of the main and inverter disconnect switches, local/remote and H-O-A switches, VFD/bypass switch, pilot lights, digital display, keypad, and any other face mounted device, along with the panel face labeling.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Unit shall be dead front construction.
- B. All relays shall be plug-in style base.
- C. All fuses shall be mounted in fuse blocks with insulated covers. Covers shall shield fuse ends and wire terminations.
- D. The VFD shall be marked with its short circuit current rating in compliance with UL.
- E. The unit, including all specified accessories, shall have a minimum efficiency of 85 percent at any speed from 50 to 100 %. The unit shall have a power factor of 0.9 or higher when operating at any speed from 50 to 100%.
- F. The VFD shall be variable torque type and shall provide full motor torque at any operating speed from 40% to 100%.
- G. The VFD shall provide variable torque V/Hz control when operating at speeds less than 100%.
- H. Provide the drive with a main input disconnect switch, accessible without opening the drive cabinet, equipped with current limiting fuses and fuse rejection clips, or circuit breakers. All other fuse blocks with current limiting fuses installed shall be equipped with fuse rejection clips. It shall be possible to padlock the disconnect in the off position.
- I. Provide minimum 6 pulse PWM type drives.
- J. Provide the necessary electronics to avoid audible noise generated from motor due to frequency change. The unit shall not increase the motor audible noise by more than 3 dB above the motor's across the line noise at any motor speed from 50 to 100 %.
- K. The unit shall include self diagnostics with a digital display that identifies fault conditions and simplifies trouble shooting. Fault indication shall be retained even after a power outage or an input over-current protective device trip.
- L. Unit shall be provided with RFI/EMI filters.
- M. Unit shall be UL, CSA or ETL labeled.
- N. VFD shall include current sensors on all three output phases to accurately measure motor current.

### VARIABLE FREQUENCY DRIVES

- O. Provide minimum 3 percent AC input line reactors and/or minimum 5 percent DC link reactors to limit the maximum current total harmonic distortion (THD) to not more than 100% of the VSD input current waveform at any VSD operating speed from 20% to 100%. Reactors shall be integral to the VSD. The reactor(s) shall not be active when the drive is in bypass mode. If testing reveals the maximum THD is exceeded, the manufacturer shall provide and install additional reactors at no cost to reduce the THD to within these specified limits.
- P. The unit shall have a dedicated terminal block for all external inputs and outputs.
- Q. Provide factory mounted and wired 115 V, 1 phase, 60 Hz control power transformer sized for handling an additional 30 VA inductive load. Limit fuse size for the control transformer to 3 amps maximum.
- R. The VFD input and output shall be rated at 480 V, 3 phase.
- S. Provide a factory mounted and wired manual bypass device as scheduled. The bypass device shall allow the load to run across-the-line while electrically isolating the VFD so that maintenance can be performed on the drive components.

# 2.2 CONTROL FEATURES

- A. The VFD shall be provided with the following control features:
  - 1. Factory mounted and wired Hand-Off-Auto selector switch that allows local or remote starting or stopping of the drive. Separate start and stop buttons, electronic circuits that "virtually" provide this capability, or other alternative devices are not acceptable.
  - 2. Factory mounted and wired VFD-Bypass switch, if bypass device is provided.
  - 3. Factory mounted and wired Local-Remote speed control switch, that allows either local or remote control of the drive speed. Key pad buttons are also acceptable provided that permanently labeled, dedicated buttons are provided for the local and the remote speed control functions.
  - 4. Main input disconnect switch.
  - 5. Inverter input disconnect switch, accessible without opening the drive cabinet, if bypass device is provided.
  - 6. Manual speed potentiometer or keypad control, for local speed control with the Local-Remote speed control switch in the Local position.
  - 7. VFD shall accept an input reference (feedback) signal, 0-10 Vdc analog input, or 4-20 mA analog input, as indicated in VFD schedule, for remote speed control with the Local-Remote speed control switch in the Remote position. Provide input signal isolation to isolate input signal ground from VFD internal control ground.
  - 8. A remote start/stop contact input that functions in the automatic mode only.
  - 9. A safety interlock circuit that functions in drive and by-pass modes.
  - 10. A run permissive circuit, separate from the safety interlock circuit, which prevents motor operation whether in drive or bypass mode. This circuit, via the customer's external contact device, signals the motor may run, provided the safety interlock contact(s) is made. A typical application would be for a time delay before motor start to allow some external event to occur. The run permissive circuit shall be jumpered from the factory.
  - 11. Provide the following drive initiated external circuits:
    - a. Powered run mode: A circuit that is powered <u>after</u> the motor is started in drive or by-pass modes.

- b. Powered run request: A circuit that is powered whenever the drive safety interlock contact(s) are closed, <u>and the drive H-O-A is in hand, or the drive H-O-A is in auto and the remote start/stop contact is closed.</u>
- 12. A standard USB port for direct connection of a Personal Computer (PC) to the VFD. The manufacturer shall provide PC software to allow complete setup and access to the VFD through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system
- 13. An integral PID controller that, when activated, controls drive speed to maintain a programmed setpoint based on a remote analog input feed-back signal.
  - a. The VFD shall be able to apply a scaling factor to the feedback signal
  - b. The VFD shall be able to calculate the square root of the feedback signal so that a pressure sensor can be used to measure flow.
- 14. A real-time clock shall be an integral part of the VFD.
  - a. It shall be possible to use this to display the current date and time on the VFD's display.
  - b. The clock shall include a time clock function with 7 day programmability and a minimum of four programmable time periods per day, with individually selectable ON and OFF functions. The time clock function shall be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. The time clock function shall be programmable through the controller display and keypad, or by included software that allows programming via a PC and a USB connection.
- 15. VFD shall be capable of starting a coasting load.
- 16. VFD shall automatically attempt to restart a minimum of three (3) times during an adjustable time period of no less than 30 seconds after shutting off for any reason, except for short circuit or motor overload.
- 17. The VFD shall have adjustable motor acceleration and deceleration rates.
- 18. The VFD shall have the ability to lock-out a minimum of four critical frequency ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment.
- 19. The VFD shall be configured as required to meet system operational requirements including:
  - a. Provide an additional set of N.O. contacts on the VFD-Bypass switch that close when the switch is set to Bypass.
  - b. Provide one normally open and one normally closed auxiliary contacts to actuate when the motor is started in any mode.
  - c. Provide a minimum of one 4-20 ma analog output signal selectable to proportionally indicate drive output frequency, current, or power, or to indicate the VFD input reference/feedback signal, for monitoring by DDC.

# 2.3 INDICATORS

- A. Indicating lamp for "POWER AVAILABLE" and for "MOTOR ON BYPASS". Lights shall be LED type.
- B. Motor RPM and AMP display factory mounted on the face of the unit, either as a separate indicator or via the controller display.

### VARIABLE FREQUENCY DRIVES

#### 2.4 SAFETIES

- A. Provide status lights or digital display indication of the cause of any shutdown.
- B. The VFD shall be provided with the following safety features:
  - 1. VFD over voltage and under voltage protection and protection against temporary power outages.
  - 2. VFD over temperature protection.
  - 3. Motor over temperature protection per NEC 430.126(A)(2).
  - 4. Short circuit and ground fault protection.
  - 5. Separate motor overload protection functional in by-pass and normal operation. For VFD's controlling multiple motors, provide overload protection for each motor.
  - 6. Adjustable current limiter.

### 2.5 LABELING

- A. Provide engraved plastic labels permanently attached to the VFD panel face indicating the function of all switches and indicators, and the equipment served.
- B. Tag all wiring in the drive. Tag nomenclature shall match the corresponding wire identification nomenclature indicated on the approved drive submittal.
- C. For VFDs serving smoke purge, stair pressurization, or other smoke control systems, include an engraved permanently attached red faced label, minimum 6" x 6", with the following nomenclature: CAUTION: THIS VFD IS PART OF A LIFE SAFETY SMOKE CONTROL SYSTEM. NOTIFY COUNTY'S DEPARTMENT OF PUBLIC SAFETY PRIOR TO ANY CHANGE OR MAINTENANCE ACTIVITY TO THIS DRIVE.

### PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Unit installation, including mounting and supports, and wiring to motor shall be by the Electrical Contractor, in compliance with Division 16. Coordinate with the Electrical Trades and Control Trades as required.
- B. Install the VFD as close as possible to the motor. The load side power cables to the motor shall be kept as short as possible and shall not be run in the same conduit as the line side power cables. Control wiring shall be in separate conduit from power wiring. Where applicable, control wires from the motor disconnect early break contacts may be installed with the motor power wiring.
- C. Protect the unit from dirt, dust, water and physical damage prior to and during construction. If the inside of the unit becomes dirty or dusty before acceptance by the County, it shall be thoroughly cleaned by the unit manufacturer at the contractor's expense.

# 3.2 CHECK, TEST AND START

A. Provide the services of a factory trained and certified technician to supervise check, test and start. The contractor shall notify County representative 5 days in advance of the start-up.

END OF SECTION 262923

# SECTION 265000 - LIGHTING

PART 1 - GENERAL

### 1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data for each luminaire, including lamps. Calculated footcandle plot, on a reasonable grid, for both interior & exterior spaces.
- B. An "Approved Equal" will be considered for most light fixture types. Pre-bid approval (10days prior) by Heinz Associates LLC and subsequent listing in an Addendum is required to bid fixtures not listed in the schedule.

### PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Fixtures, Emergency Lighting Units, 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 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Exterior Luminaires: Comply with UL 1598 and listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- F. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

### 2.3 EXIT SIGNS

- A. Internally Lighted Signs: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
  - 1. Lamps for AC Operation: LEDs, 70,000 hours minimum of rated lamp life.

# 2.4 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
  - 1. Battery: Sealed, maintenance-free, lead-acid type.
  - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  - 3. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  - 4. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

# PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Coordinate ceiling-mounted luminaires with ceiling construction, mechanical work, and security and fire-prevention features mounted in ceiling space and on ceiling.
- B. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- C. Comply with NFPA 70 for minimum fixture supports.
- D. Seismic Protection: Luminaire attachments to building walls and ceilings shall comply with seismic criteria in Section 260500 "Common Work Results for Electrical."
- E. Suspended Lighting Fixture Support:
  - 1. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  - 2. Non-Stem-Mounted Fixtures: Suspend with aircraft cable & SO cord.
  - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- F. Air-Handling Fixtures: Install with dampers closed and ready for adjustment.
- G. Adjust aimable lighting fixtures to provide required light intensities.

### END OF SECTION 265000

# SECTION 270506 – TELECOMMUNICATIONS GROUNDING AND BONDING

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.
- B. Related Sections:
  - 1. Division 27 Section "Pathways for Communications Systems."
  - 2. Division 27 Section "Communications Horizontal Cabling".
  - 3. Division 27 Section "Telecommunications Grounding and Bonding".

#### 1.2 DEFINITIONS

- A. Bonding The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.
- B. Bonding Conductor for Telecommunications (BCT) A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.
- C. Telecommunications Bonding Backbone (TBB) A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar (TGB).
- D. Telecommunications Grounding Busbar (TGB) The interface to the building telecommunications grounding system generally located in telecommunications room. A common point of connection for telecommunications system and equipment bonding to ground, and located in the telecommunications room or equipment room.
- E. Telecommunications Main Ground Busbar (TMGB) A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications to the building service equipment (power) ground.

### 1.3 SUMMARY

- 1. This Section specifies the minimum requirements for a complete telecommunications bonding and grounding infrastructure and its interconnection to electrical systems and telecommunications systems.
- 2. Provide, install, and test a complete grounding (earthing) and bonding system for the telecommunications infrastructure. Telecommunications Infrastructure components will achieve a common ground with the Building's electrical system ground.

- 3. Reference the Grounding and Bonding Diagram in the associated drawings for a schematic of the minimum required connectivity.
  - a. At minimum, the system shall bond together all racks/cabinets, cable tray, ladder rack, and other metallic components within each ER/TR, bond each TR to the ER, and bond the resulting grounding system with the Electrical grounding system.
  - b. Label, Test, and document the entire system.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Provide as a single complete system submittal with master product list referencing each paragraph in this section specifying product.

### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include the following in operation, and maintenance manuals:
  - 1. Instructions for periodic testing and inspection of grounding features at grounding connections.

### 1.6 QUALITY ASSURANCE

- A. All installation practices shall be fully compliant with:
  - 1. ANSI-J-STD-607-B-2011, "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises."
  - 2. ANSI/NECA/BICSI-607, "Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings."
- B. All Work shall fully comply with these Specifications and related Drawings and all manufacturers recommended installation practices.

# PART 2 - PRODUCTS

### 2.1 GROUNDING AND BONDING BUSBARS

- A. General:
  - 1. Locate TGB at working height. Coordinate location with Engineer.
- B. Telecommunications Main Grounding Busbar (TMGB): (NOT USED ON THIS BID)
  - 1. Erico Electrical Products <sup>1</sup>/<sub>4</sub>" thick x 4" high x 16" wide ground busbar assembly Part Number B544A028 or approved equal.

- C. Telecommunications Grounding Busbar (TGB):
  - 1. Panduit 2" Buss Bar PN: SBB/TGB connected to the rack and cable tray with a Panduit RGEJ1024PFY Equipment Jumper Kit.
- D. Equipment rack busbar: (NOT USED ON THIS BID)
  - 1. As specified in Division 27 "Communications Equipment Room Fittings."

### 2.2 BONDING CONDUCTORS

A. All bonding conductors shall be green insulated copper unless otherwise noted. Unless otherwise specified, size conductors as required by ANSI-J-STD-607-A. In plenum spaces bare copper may be used.

### PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. All Work shall fully comply with these Specifications and related Drawings and all manufacturers recommended installation practices.
- B. Provide all grounding and bonding as specified in the Contract Documents.
- C. Ground electrical systems and equipment as required by code, utility, local ordinances, and requirements herein.
- D. Bonding conductors shall be continuous and routed in a direct path to point of termination.
- E. All grounding busbars shall be isolated from the structure support by a 2-inch minimum separation using manufacturer's recommended insulating stand-offs and hardware.
- F. Clean grounding busbars before terminating conductors.
- G. Do not place busbars on exterior walls.

### 3.2 LABELING

- A. Label the ends of all conductors.
- B. Label conductors consecutively within each ER/TR 01 through "xx" with "xx" representing the last number in order.
- C. Label all TGBs and the TMGB as identified on the Drawings and with the following:

### WARNING!!!

## IF THIS CONNECTOR OR CABLE IS

#### TELECOMMUNICATIONS GROUNDING AND BONDING

## LOOSE OR MUST BE REMOVED

# PLEASE CALL THE BUILDING

#### TELECOMMUNICATIONS MANAGER.

#### 3.3 CONNECTIONS

- A. Bond the TMGB to the service equipment (power) ground, typically located in the electrical entrance facility, using the most direct route possible to minimize conductor length. THIS WILL BE PROVIDED BY THE ELECTRICAL CONTACTOR.
- B. Bond all TGBs to the TMGB using specified conductor.
- C. Bond the following to the TMGB when present:
  - 1. Telecommunications panelboard:
    - a. Alternating Current Equipment Ground Bus (ACEG), if equipped, or its enclosure.
  - 2. Building structural steel, if exposed. (Steel rebars of reinforced concrete are not required to be bonded.)
  - 3. Metallic equipment racks.
  - 4. Cable shields.
  - 5. All metal raceways and cable trays for telecommunications cabling extending from the same room or space where the TMGB is located.
  - 6. Floor tile ground tab if provided.
  - 7. Others as identified on the Drawings.
- D. Bond the following to the TGB when present:
  - 1. Telecommunications panelboard: Alternating Current Equipment Ground Bus (ACEG), if equipped, or its enclosure.
  - 2. Building structural steel, if exposed. (Steel rebars of reinforced concrete are not required to be bonded.)
  - 3. TGBs within the same space if provided.
  - 4. TBBs terminated on the same floor to other TGBs.
  - 5. Metallic equipment racks.
  - 6. Cable shields.
  - 7. All metal raceways and cable trays for telecommunications cabling extending from the same room or space where the TMGB is located.
  - 8. Floor tile ground tab if provided.
  - 9. Others as identified on the Drawings.
- E. Terminate Bonding Conductor for Telecommunications and TBB conductors with two-hole compression lugs.
- F. Terminate all other conductors with one-hole compression lugs.

## 3.4 BONDING

- A. General:
  - 1. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
    - a. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
    - b. Make connections with clean bare metal at points of contact.
    - c. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

# 3.5 TESTING

- A. Purpose:
  - 1. The purpose of this test is to ensure proper grounding of the telecommunications system.
- B. Test equipment:
  - 1. Biddle Instruments, Megger DET2/2 Ground Tester or later approved model.
- C. Testing guidelines:
  - 1. The following testing guidelines apply to all test procedures and shall be followed to promote efficient and accurate testing:
    - a. Be sure all connections are tight. Loose connections will drastically affect the test results.
    - b. The test lead shall be No. 14 AWG, stranded, insulated copper conductor. The test lead shall be long enough to reach all TGBs from the TMGB. One test lead shall be used for all tests.
    - c. The test lead may be spooled. However, the Biddle meter may produce inaccurate or erratic resistance measurements if the quantity of cable on the spool is too great. If the meter behaves erratically, first try to perform the test in the "low current" setting. If the behavior persists, the lead should be unspoiled.
    - d. The current shall be set to "High."
    - e. The filter shall be set to "On."
    - f. The frequency shall be set to "150 Hz."
    - g. Connect Terminals C2 and P2 by a jumper wire (if not connected by the manufacturer).
    - h. Connect Terminals P1 and C1 by a jumper wire (if not connected by the manufacturer).
    - i. Once the test lead is attached to the meter it should not be removed as identified in the specific test procedure.
- D. Reference test:

- 1. The reference test procedure is necessary to calibrate the test setup. Perform the reference test procedure before performing any test.
- 2. Record the reference value and subtract from all other measurements. If the length of the test lead is changed, perform and record new test data.
- E. Reference test procedure:
  - 1. Perform the test procedure as follows:
    - a. Connect one end of the test lead to Terminal C1 and the other end to Terminal C2.
    - b. Perform the Biddle Meter Resistance Test.
    - c. Record test lead resistance on the data sheet.
    - d. Disconnect the test lead from Terminal C1 ONLY. The test lead shall remain connected to Terminal C2 throughout the test.
- F. Ground reference system continuity test:
  - 1. The ground reference system shall be tested to validate the continuity and integrity of the interconnection of the system and the building's grounding electrode.
- G. Ground reference system continuity test procedure:
  - 1. Perform the test procedure as follows:
    - a. Remove all conductors except the TBB and the Bonding Conductors for Telecommunications from the TMGB and the TGBs.
    - b. Move the meter and test lead to the first TGB to be tested. Route and connect the test lead to the TMGB. The other end of the test lead should still be connected to Terminal C2 from the reference test. Connect a short test lead from Terminal C1 to the TGB to be tested.
    - c. Perform the Biddle Meter Resistance Test.
    - d. Record the resistance on the data sheet.
    - e. Attach the equipment bonding conductor from the panelboard located within the room to the TGB and repeat the test. Record the resistance on the data sheet.
    - f. Attach the equipment bonding conductor from the building steel (if applicable) and repeat the test. Record the resistance on the data sheet.
- H. Leave the building steel and panelboard ground connected to this TGB. Repeat the test for all other TGBs.

END OF SECTION 270506

# SECTION 271500 – COMMUNICATIONS COPPER HORIZONTAL CABLING

#### 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.

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. N/A.
- B. Related Requirements:
  - 1. N/A

#### 1.1 DEFINITIONS

- 1. Furnish: Supply and deliver to Project site, ready for unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- 2. Install: Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- 3. Provide: Furnish and install, complete and ready for the intended use.

### 1.1 WORK INCLUDED

- A. Provide all labor, material, tools, and equipment for the complete installation of work called for in the construction documents.
- B. The contractor is directed to examine each and every section of the specifications, all drawings relating to the Contract Documents, any and all Addenda, etc., for work described that may relate to the provision of the work described herein. Materials and performance are specified herein that relate to these systems.
- C. The use of proprietary or copyrighted names or reference to patented trade items with this specification or elsewhere in the Contract Documents is meant to establish a standard of quality and performance. All materials and equipment proposed for installation must meet or exceed all specified requirements.

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

### 1.2 SCOPE OF WORK

- A. Coordinate a pre-construction meeting with the Owner's representatives to discuss project requirements, including cable routing, outages, general expectations, etc.
- B. Install one (1) Genspeed 6500E CAT6 data drop (plenum-rated) to each general data location. Terminate in CAT6 module in a 1-port recessed box. Test cable and label. Provide for two (2) CAT6 patch cables – one (1) each at the general data & patch panel ends.
- C. Install one (1) Genspeed 6500E CAT6 data drop (plenum-rated) to each security camera location. Terminate in CAT6 module in a 1-port surface-mount box. Leave a 10' foot coil at each location and suspend from a 3/4" J-Hook. Label the box and the ceiling grid directly below the box. Test cable and label. Provide for two (2) CAT6 patch cables one (1) each at the camera & patch panel ends. Security cameras will be provided & installed by the camera vendor.
- D. Install two (2) Genspeed 6500E CAT6 data drops (plenum-rated) to each wireless access point (WAP) location. Terminate in CAT6 modules in a 2-port surface-mount box. Leave 10' foot coils at each location and suspend from a 3/4" J-Hook. Label the box and the ceiling grid directly below the box. Test cables and label. Provide for four (4) CAT6 patch cables two (2) each at the WAP & patch panel ends. WAP's will be provided & programmed by Owner, and installed by contractor. Note: WAP's shown on construction drawings are approximate locations. Coordinate a meeting with the Owner's representatives to discuss final locations.
- E. Install one (1) Genspeed 6500E CAT6 data drop (plenum-rated) to the fire alarm control panel. Leave a 10' foot coil at the location and suspend from a 3/4" J-Hook. Terminate & test cable and label. Provide for one (1) CAT6 patch cable at the patch panel end.
- F. Install one (1) Genspeed 6500E CAT6 data drop (plenum-rated) to the power monitor mounted on electrical main switchgear. Leave a 10' foot coil at the location and suspend from a 3/4" J-Hook. Terminate & test cable and label. Provide for one (1) CAT6 patch cable – at the patch panel end.
- G. Install (5) Genspeed 6500E CAT6 data drops (plenum-rated) for the specialty lighting control system (4) drops from the POE switch to each LCD touchscreen, and (1) drop from the touchscreen interface to the POE switch. Drops to be 8P8C terminated. Coordinate cabling & installation requirements with lighting control vendor.
- H. Where existing & proposed cable trays aren't present, provide J-Hooks sized to support new cables. New cables will require supports no less than 5'-0" apart in all locations. Existing J-Hooks may be re-used if they are category-rated and properly sized to support the bundle.
- I. In addition to all data drops shown on construction documents, Contractor shall provide for (5) additional data drops (maximum 295-ft lengths), to be incorporated into design during the construction duration.

- J. Remove & dispose of all abandoned cables and associated hardware. Provide hardware back to Owner.
- K. Adjust rack as necessary and provide for anchoring into concrete floor slab.
- L. Provide for new 48-port patch panel with strain relief bars. Install black blanks on all vacant port slots.
- M. Install buss bar on building wall and connect to rack & cable tray. Electrical Contractor will connect buss bar to building ground network with correctly sized conductor. Low Voltage Contractor shall coordinate this work with Electrical Contractor.
- N. Test all cables and have certified by RCDD. These should be stamped with RCDD stamp and (1) paper copy and (1) electronic copy provided to Owner.
- O. Within (60) days of job completion, provide CAD as-built drawings to the owner in electronic and paper versions. As-builts should reflect approximate cable routing, rack details and print out of drop locations showing room, Hub Room, Patch Panel and Port numbers. Coordinate a meeting with the Owner's representatives to discuss final requirements.
- P. This is a PANDUIT Project. No substitutions on UTP cable or hardware. Refer to Approved Material List at the end of this section.

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Category 6 twisted pair cable.
  - 2. Twisted pair cable hardware, including plugs and jacks.
  - 3. Cabling identification products.
  - 4. Grounding provisions for twisted pair cable.
  - 5. Source quality control requirements for twisted pair cable.

## 1.2 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.

#### COMMUNICATION COPPER HORIZONTAL CABLING

- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

### 1.3 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
  - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
  - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
  - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Provide as a single complete system submittal with master product list referencing each paragraph in this section specifying product.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, installation supervisor, and field inspector.

#### 1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Contractor responsible for this Section shall have a Registered Communications Distribution Designer (RCDD) on staff who will oversee and be responsible for this Project. RCDD shall have sufficient experience in this type project to be able to lend adequate technical support to field forces during installation, warranty period, and extended warranty periods or maintenance contracts.
  - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present any time work of this Section is performed at Project site.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
  - 1. Test each pair of twisted pair cable for open and short circuits.

#### 1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

#### 1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

# PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

### 2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
  - 1. Communications, Non-plenum: Type CMR complying with UL 1666.
  - 2. Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.
  - 3. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

#### 2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. General Cable; General Cable Corporation
- D. Panduit
- E. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- F. Conductors: 100-ohm, 23 AWG solid copper.
- G. Shielding/Screening: Unshielded twisted pairs (UTP).
- H. Cable Rating: Plenum.
- I. Jacket: color thermoplastic as follows:
  - 1. To be determined by Owner.

#### COMMUNICATION COPPER HORIZONTAL CABLING

## 2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. This project is a Panduit certified project. UTP cable can be Panduit or General GenSpeed 6500E Category 6.
- C. General Requirements for Twisted Pair Cable Hardware:
  - 1. Comply with the performance requirements of Category 6e and 6A.
  - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
  - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Connecting Blocks:
  - 1. 110-style IDC for Category 6e.
  - 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
  - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
  - 1. Features:
    - a. Universal T568A and T568B wiring labels.
    - b. Labeling areas adjacent to conductors.
    - c. Replaceable connectors.
    - d. 24 or 48 ports.
  - 2. Construction: 16-gauge steel and mountable on 19" equipment racks.
  - 3. Number of Jacks per Field: One for each four-pair cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
- G. Patch Cords: Factory-made, four-pair cables in 5'-0" lengths at the patch panel end and 10'-0" lengths at the workstation end; terminated with an eight-position modular plug at each end.
  - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

#### COMMUNICATION COPPER HORIZONTAL CABLING

- 2. Patch cords shall have color-coded boots for circuit identification.
- 3. Provide (2) patch cables per horizontal cable installed, utilizing lengths listed above for bidding purposes. Confirm exact lengths with Owner's representatives prior to ordering. Excessive slack at the patch panel is not acceptable. Owner shall install patch cables at patch panel end, and Contractor shall install patch cables at workstation end. Coordinate with Architect/Owner.
- H. Plugs and Plug Assemblies:
  - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
  - 2. Standard: Comply with TIA-568-C.2.
- I. Jacks and Jack Assemblies:
  - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
  - 2. Designed to snap-in to a patch panel or faceplate.
  - 3. Standard: Comply with TIA-568-C.2.
- J. Faceplate:
  - 1. Two, Four, or Six port, vertical single gang faceplates designed to mount to single gang wall boxes. Faceplate port quantity determined by the number of cables to be installed per the drawings at each location. Any unused ports to be blanked off.
  - 2. Eight, Ten, or Twelve port, vertical double gang faceplates designed to mount to double gang wall boxes. Faceplate port quantity determined by the number of cables to be installed per the drawings at each location. Any unused ports to be blanked off.
  - 3. If existing wall conduit is being used, the faceplate will be determined by the existing box size. Bid either single or two gang based on field conditions.
  - 4. All faceplates will be stainless steel.
  - 5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
  - 6. Wall locations will require stainless steel plates with lugs for mounting phone.
    - a. Flush mounting jacks, positioning the cord at a 90-degree angle.
- K. Legend:
  - 1. Machine printed, in the field, using adhesive-tape label.
#### 2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

#### 2.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

#### 2.7 SOURCE QUALITY CONTROL

- A. Factory test cables on reels according to TIA-568-C.1.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

## PART 3 - EXECUTION

#### 3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
  - 1. Install plenum-rated cable.
  - 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

# 3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270536 "Cable Trays for Communications Systems."
- D. Contractor responsible for sleeve coring/installation shall be determined prior to bid, discussed between the Electrical Contractor and associated Low Voltage Subcontractor. It is assumed that sleeves between floors and through walls will be provided by the Electrical Contractor.

#### 3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
  - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
  - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
  - 3. Install 110-style IDC termination hardware unless otherwise indicated.
  - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
  - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  - 6. MUTOA shall not be used as a cross-connect point.
  - 7. Cables may not be spliced. 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.
  - 8. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
  - 9. 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," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
  - 10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 12. In the communications equipment room, install a 10 foot long service loop on each end of cable.
  - 13. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- C. Open-Cable Installation:

- 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
- 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
- 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.
- E. Separation from EMI Sources:
  - 1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
  - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
  - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2 1/2 inches.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
  - 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
  - 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches1200 mm.
  - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

#### 3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

#### 3.5 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-B and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least 2 inches clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

#### 3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Administration Class: Class 2.
  - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.
- C. Cable Schedule: Install in a prominent location in Hub Room and any other wiring closets. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
  - 1. Label each cable within 6 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

- 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
- 3. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
  - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a buildingmounted device, with the name and number of a particular device.
  - b. Label each unit and field within distribution racks and frames.
- 4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
  - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

## 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Visually inspect twisted pair cabling jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

## APPROVED MATERIAL PART LIST:

ITEM	MANUF.	PART #
3' SHIELDED RED PATCH CORD	PANDUIT	STP6X3RD
3' ORANGE PATCH CORD	PANDUIT	UTPSP3ORY
3' PURPLE PATCH CORD	PANDUIT	UTPSP3VLY
3' GREEN PATCH CORD	PANDUIT	UTPSP3GRY
10' SHIELDED RED PATCH CORD	PANDUIT	STP6X10RD
10' ORANGE PATCH CORD	PANDUIT	UTPSP10ORY
2 PORT SURFACE BOX	PANDUIT	CBX21W-AY
1 PORT SURFACE BOX	PANDUIT	CBX11W-A
8" GROUND STRAPS (CABLE TRAY)	PANDUIT	GACBJ68U
EQUIPMENT JUMPER KIT	PANDUIT	RGEJ1024PFY
2U HORIZONTAL WIRE MANGER	PANDUIT	WMPH2E
1U HORIZONTAL WIRE MANAGER	PANDUIT	WMPSE
4" VERTICAL WIRE MANAGER	CPI	13911-703
18" CABLE TRAY	CPI	10250-X18
4" WATERFALL DROP	PANDUIT	CWF400
CABLE TRAY RADIUS	CPI	14304-X18
CABLE TRAY RADIUS	CPI	12100-X18
RACK TO RUNWAY MOUNT	CPI	10595-X18
48 PORT PATCH PANEL	PANDUIT	CPP48FMWBLY
24 PORT PATCH PANEL	PANDUIT	CPP24FMWBLY
GENSPEED 6500 PLENUM ORANGE	GENERAL	7131935
GENSPEED 6500 PLENUM PURPLE	GENERAL	7131939
GENSPEED 6500 PLENUM GREEN	GENERAL	7131976
CAT6A RED SHEILED PLENUM	GENERAL	714590
ORANGE CAT6 MODULES	PANDUIT	CJ688TGOR
GREEN CAT6 MODULES	PANDUIT	CJ688TGGN
PURPLE CAT6 MODULES	PANDUIT	CJ688TGVL
RJ45 SHIELED JACK	PANDUIT	SP5688-C
4 PORT SINGLEGANG FACEPLATE	PANDUIT	CFP4IW
2 PORT SINGLE GANG FACEPLATE	PANDUIT	CFP2IW
4 PORT DOUBLE GANG FACEPLAE	PANDUIT	CFPE10IW-2GY
MODULE BLANKS	PANDUIT	CMBIW-X
2" BUSS BAR	PANDUIT	SBB/TGB
STRAIN RELIEF BARS	PANDUIT	SRB19D5BL

SUPPLY ANY MISC MATERIAL TO COMPLETE THE JOB AS CALLED OUT ON THE CONSTRUCTION DRAWINGS.

## The Vincennes University Cabling Standard below shall supersede any other construction specification.

Please use the following list of standards for any network cabling installations or upgrades. If you have any questions regarding any of these, please contact the Management Information Center.

Panduit parts and numbers:

CPP48FMWBLY	48 port modular patch panel	
CPP24FMWBLY	24 port modular patch panel	
CJ688TGGR	Green modular jack	Use for WiFi equipment
CJ688TGRD	Red modular jack	Use for sensitive or protected equipment
CJ688TGOR	Orange modular jack	Use for standard data devices (computers)
CJ688TGYL	Yellow modular jack	Use for AV equipment
CJ688TGIW	White modular jack	Use for voice specific devices
CJ688TGPR	Purple modular jack	Use for cameras
CFPE2WHY	White modular wall faceplate	Use for all jacks

At the current time the current cabling standard is CAT6, plenum-rated cable. No need to go with the higher cost CAT6A cabling at this time.

CAT6 cable colors to match the jacks listed above:

Red

Green

White

Orange

Yellow

Purple

#### **Red cable and jacks for critical equipment such as servers**

Orange cable and jacks for lab and employee computers.

#### Green cable and jacks for wireless access points.

Yellow cable and jacks for televisions and other displays.

Purple cable and jacks for security cameras.

# All HVAC temperature controls CAT-rated cabling shall be blue, to minimize confusion between other cable colors.

# **Cable Handling**

## Length

The maximum horizontal cable length is 90 m (295 ft); 10 m is allowed for cords in the work area and for patch cords or jumpers in the telecommunications closet.

The maximum backbone cable length is typically 90 m (295 ft), but this number now depends on media and applications. A 90 m length assumes that 5 m (16 ft) are needed at each end for equipment cables connecting to the backbone.

The maximum length for equipment cords and patch cords or jumpers is 10 m. Up to three cords can be used totaling no more than 10 m (33 ft).

# Pulling Tension

Maximum pulling tension for a 4-pair horizontal cable is 25 lbf. Excessive pulling tensions may occur during installation. Once the damage is done, reversing the effect may not be sufficient enough to correct the problem; in this scenario, cable replacement is recommended. Intermediate cable pulls within the overall cable run may be necessary to avoid exceeding the maximum pulling force.

## Minimum Bend Radius

Minimum bend radius can be calculated by multiplying the outside diameter (OD) of the cable by 4. For example, if you have a cable with an OD of .250, the minimum bend radius can be determined this way:

# 4 x .250 = 1"

CAUTION: Exceeding the minimum bend radius can distort cable geometry and result in degradation of transmission performance.

Repositioning the cable to the proper bend radii may not correct the fault. Once the damage is done, the best option is to replace the damaged run.

There are two common places where exceeding the minimum bend radius may occur:

- At the **workstation wall outlet**. After the cable is terminated, too often the remaining cable is jammed into the wall outlet (or worse, wrapped around itself and shoved into the outlet). A better practice is to gently work the excess cable length back through the wall outlet into the wall.
- At the **wiring closet** and during **cable routing** to the terminal block or patch panel. Prior cable placement practices may have encouraged making the cable appear as form fitting or tight against the routing structure (cable tray or rack) as possible. A better practice is to incorporate gently sweeping curves along the cable path, avoiding sharp bends or changes in direction. Every effort should be made to ensure the path the cable follows has smooth, gradual sweeps at any transition point.

# Overstressing

Eliminate cable stress caused by tension in suspended cable runs and tightly cinched cable bundles.

Excessive cable loading or stress can also occur if a cable is incorrectly suspended in a cable run. A recommended cable support spacing is 48" to 60" centers.

Avoid twisting of cable during installation. Excessive twisting may result in distortion of cable geometry and, in severe cases, tears in the jacket.

In addition to the above guidelines extracted from ANSI/TIA-568-C, Mohawk strongly recommends the following supplementary installation tips:

- Do not walk or step on high-performance cable. Do not run over high-performance cable with hand trucks or forklifts. This can exert excessive force on the cable, distorting the geometry and/or crushing the pairs, resulting in electrical shorts.
- Do not use staples, either from a staple gun or mounting in a traditional manner with a hammer. Staples can exert excessive force on the cable and distort the pair geometry.
- D-Rings, nail-on clamps or Velcro straps all offer acceptable cable-management techniques without compressing the cable.
- Do not run cable near sources of heat; this may negatively impact cable attenuation.
- Maintain a 6" minimum spacing between cables and sources of EMI, such as fluorescent lights or unshielded power lines

# • Termination

The installer must be acquainted with the connector manufacturer's installation instructions. The correct tools, wire layout and untwist length are critical, especially in Category 6 installations. Modular jacks usually have the pair color code marked on the jack. The color code can be either T568A or T568B wiring methods. Maintain the same pin-to-pair combination throughout the installation. Changing pin-pair assignment can result in crossed pairs. Modular jacks and cross-connect blocks employ IDC connectors to complete the circuit between the cable and the hardware. The manufacturer will recommend the tools needed to terminate the cable.

- Terminate with connecting hardware of the same category or higher. Any link that has substituted a lower-category component is automatically classified to that lower category.
- The maximum allowable amount of untwisting during cable termination to connecting hardware is 0.5" for Category 5e and Category 6 cables. Exceeding the recommended length of untwisting may cause performance problems. The same techniques should be employed when terminating cross-connect blocks. Maintaining jacket integrity to the point of termination aids in maintaining cable geometry and NEXT isolation from adjacent cable pairs.
- When terminating F/UTP cable, follow the same guidelines as listed above. Additionally, termination of the thin foil shield and drain wire are important to maintain shield continu-

ity and shielding effectiveness from the cable to the connector. The connector manufacturer's installation instructions should be followed for shielded cable termination.

• Bridged taps and splices are not permitted as part of copper horizontal cabling requirements.

# Examples of installations where industry and University standards are followed:







END OF SECTION 271500

## SECTION 283100 – FIRE DETECTION AND ALARM

PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Electrical Contractor shall remove & replace entire existing fire alarm system, to accommodate all existing & new equipment in building. Contractor shall provide for complete fire detection/alarm system fully operational including devices, wiring, alarms, to meet all applicable jurisdictional requirements, including State of Indiana and City of Vincennes.
- B. Only Johnson Controls, Inc. and Innovative Fire & Security in Evansville, IN are approved fire alarm contractors, by Owner.
- C. Contractor to assist Owner in account set-up with monitoring company. Monitoring company selection by Owner.

#### 1.2 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.
- C. Maintenance of fire alarm system under contract for specified warranty period.

#### 1.3 RELATED REQUIREMENTS

- A. Section 08 71 00 Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
- B. Section 21 13 00 Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- C. Section 14 20 10 Passenger Elevators: Elevator systems monitored and controlled by fire alarm system.
- D. Section 23 33 00 Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

#### 1.4 REFERENCE STANDARDS

- A. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits; 2002 (R2008).
- B. NFPA 70 National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NFPA 72 - National Fire Alarm Code and Signaling Code; 2010.

## 1.5 SUBMITTALS

- A. See Section 01 30 00 Administrative Requirements, for submittal procedures.
- B. Evidence of designer qualifications.
- C. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
  - 1. Copy (if any) of list of data required by authority having jurisdiction.
  - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
  - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
  - 4. System zone boundaries and interfaces to fire safety systems.
  - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
  - 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
  - 7. List of all devices on each signaling line circuit, with spare capacity indicated.
  - 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
  - 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
  - 10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
  - 11. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
  - 12. Certification by Contractor that the system design complies with the contract documents.
- D. Evidence of installer qualifications.
- E. Evidence of instructor qualifications; training lesson plan outline.
- F. Evidence of maintenance contractor qualifications, if different from installer.
- G. Inspection and Test Reports:
  - 1. Submit inspection and test plan prior to closeout demonstration.
  - 2. Submit documentation of satisfactory inspections and tests.
  - 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- H. Operating and Maintenance Data: See Section 01 78 00 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
  - 1. Complete set of specified design documents, as approved by authority having jurisdiction.
  - 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.

- 3. Contact information for firm that will be providing contract maintenance and trouble callback service.
- 4. List of recommended spare parts, tools, and instruments for testing.
- 5. Replacement parts list with current prices, and source of supply.
- 6. Detailed troubleshooting guide and large scale input/output matrix.
- 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
- 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- I. Project Record Documents: See Section 01 78 00 for additional requirements; have one set available during closeout demonstration:
  - 1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
  - 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
  - 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- J. Closeout Documents:
  - 1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
  - 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
  - 3. Maintenance contract.
- K. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
  - 1. See Section 01 60 00 Product Requirements, for additional provisions.

#### 1.6 QUALITY ASSURANCE

- A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
  - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
  - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
  - 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.

- C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
- D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

## 1.7 WARRANTY

- A. See Section 01 78 00 Closeout Submittals, for additional warranty requirements.
- B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 5 years after date of Substantial Completion.
- C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

#### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Fire Alarm Control Units Basis of Design: Siemens.
- B. Fire Alarm Control Units Other Acceptable Manufacturers: Provided their products meet or exceed the performance of the basis of design product, products of the following are acceptable:
  - 1. Siemens.
  - 2. Honeywell.
  - 3. Provide all control units made by the same manufacturer.
- C. Substitutions: See Section 01 60 00 Product Requirements.
  - 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with contract documents.

#### 2.2 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
  - 1. Provide all components necessary, regardless of whether shown in the contract documents or not.
  - 2. Protected Premises: Entire building shown on drawings.
  - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
    - a. The Americans With Disabilities Act (ADA).
    - b. The requirements of the local authority having jurisdiction.
    - c. Applicable local codes.
    - d. The contract documents (drawings and specifications).

- e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
- 4. Evacuation Alarm: Single smoke zone; general evacuation of entire premises.
- 5. Combined Systems: Do not combine fire alarm system with other non-fire systems.
- B. Supervising Stations and Fire Department Connections:
  - 1. Remote Supervising Station: UL-listed central station under contract to facility.
  - 2. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), 2 telephone lines.
- C. Circuits:
  - 1. Initiating Device Circuits (IDC): Class B, Style A.
  - 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
  - 3. Notification Appliance Circuits (NAC): Class B, Style W.
- D. Spare Capacity:
  - 1. Initiating Device Circuits: Minimum 25 percent spare capacity.
  - 2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
  - 3. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E. Power Sources:
  - 1. Primary: Dedicated branch circuits of the facility power distribution system.
  - 2. Secondary: Storage batteries.
  - 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

## 2.3 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
  - 1. Sprinkler water control valves.
  - 2. Dry-pipe sprinkler system pressure.
  - 3. Manual Station.
  - 4. Fire Standpipe System.
  - 5. System Smoke Detector.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
  - 1. Sprinkler water flow.
  - 2. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
- C. Elevators:
  - 1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
- D. HVAC:

- 1. Area Smoke Detectors/Duct Smoke Detectors: Close dampers individually by associated smoke detector/duct smoke detector activation; shut down air handlers indicated.
- 2. Provide return air duct smoke detector on all fan coil units greater than or equal to 2000 cfm. If no return air ductwork is installed at these fan coil units, install duct smoke detector in supply air ductwork.
- 3. Provide supply & return air duct smoke detectors on all MAU's & AHU's greater than or equal to 15,000 cfm. If no return air ductwork is installed at these MAU's & AHU's, install duct smoke detector in supply air ductwork only. Provide adequate quantity of duct smoke detectors in large ducts, as required per Code.
- 4. Fire/smoke and smoke dampers in this building are provided by Mechanical Contractor. These dampers have a 120V electric actuator.
- 5. Provide 120V power from nearest power panel to power all fire/smoke dampers. Connect as many dampers to each branch circuit so the circuit is loaded to no more than 70% of its capacity.
- E. Doors:
  - 1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.

## 2.4 COMPONENTS

- A. GENERAL:
  - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
  - 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

#### B. FIRE ALARM CONTROL PANEL (FACP)

- 1. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- 2. The following FACP hardware shall be provided:
  - a. FACP to have dual dial-out capability. For bid purposes, provide for cellular/IP dialer. Confirm preferred dual dial-out methods with Owner.
  - b. Power Limited base panel with red cabinet and door, 120 VAC input power.
  - c. 10,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
  - d. 10,000 points of Network Annunciation at FACP Display when applied as a Network Node.
  - e. 10000 points of annunciation where one (1) point of annunciation equals:
    - 1) 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
    - 2) 1 LED on panel or 1 switch on panel.
  - f. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FCP LCD Display.
  - g. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.

- h. One Auxiliary electronically resetable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
- i. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
- j. Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
- k. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
- 1. The FACP shall support (6) RS-232-C ports and one service port.
- m. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
- n. Programmable DACT for either Common Event Reporting or per Point Reporting.
- o. Service Port Modem for dial in passcode access to all fire control panel information.
- 3. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.
- 4. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands. 4100-315 Specifications

## C. AUTOCALL SYSTEM INTERFACE

1. When a fire alarm system using existing Autocall XA loop devices requires expansion FACP shall be capable of interfacing to the XA loop via an interface module. This module shall allow the FACP to be selected to function as either the XA loop master controller (head end) or as a Data Gathering Panel as an intelligent device on the XA loop reporting to a remote master controller. Multiple XA Loop Interface Modules can be installed in the FACP allowing a variety of system expansion situations to be satisfied.

#### D. REMOTE LCD ANNUNCIATOR

- 1. Provide where required a remote LCD Annunciator with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys, Status LEDs and LCD Display as the FACP.
- 2. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.
- 3. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.
- 4. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
- 5. The LCD shall display the following information relative to the abnormal condition of a point in the system:
  - a. 40 character custom location label.
  - b. Type of device (e.g., smoke, pull station, waterflow).
  - c. Point status (e.g., alarm, trouble).

6. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

## E. EMERGENCY POWER SUPPLY

- 1. General: Components include battery, charger, and an automatic transfer switch.
- 2. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 15 minutes.

#### F. ADDRESSABLE MANUAL PULL STATIONS

- 1. Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- 2. Protective Shield: Where indicated on drawings, provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

#### G. SMOKE SENSORS

- 1. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
  - a. Factory Nameplate: Serial number and type identification.
  - b. Operating Voltage: 24 VDC, nominal.
  - c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
  - d. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
  - e. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
  - f. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
  - g. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
  - h. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.

- i. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
- j. Removal of the sensor head for cleaning shall not require the setting of addresses.
- 2. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type. Where acceptable per manufacturer specifications, ionization type sensors may be used.
- 3. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.
- 4. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
  - a. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
  - b. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
  - c. Duct Housing shall provide a relay control trouble indicator Yellow LED.
  - d. Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
  - e. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
  - f. Duct Housing shall provide a magnetic test area and Red sensor status LED.
  - g. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
  - h. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch.
  - i. Where indicated provide a NEMA 4X weatherproof duct housing enclosure shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.

## H. HEAT SENSORS

- 1. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- 2. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- 3. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
- 4. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

#### I. ADDRESSABLE CIRCUIT INTERFACE MODULES

- 1. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and AHU systems.
- 2. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required.
- 3. There shall be the following types of modules:
  - a. Type 1: Monitor Circuit Interface Module:
    - 1) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
    - 2) For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.
  - b. Type 2: Line Powered Monitor Circuit Interface Module
    - 1) This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.
    - 2) This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.
  - c. Type 3: Single Address Multi-Point Interface Modules
    - 1) This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
    - 2) This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
    - 3) This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using

a single address. The two-wire signaling line circuit shall supply power and communications to the module.

- d. Type 4: Line Powered Control Circuit Interface Module
  - 1) This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.
- e. Type 5: 4-20 mA Analog Monitor Circuit Interface Module
  - 1) This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.
- 4. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

#### J. ADDRESSABLE ALARM NOTIFICATION APPLIANCES

- 1. Addressable Notification Appliances: The Contractor shall furnish and install Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).
  - a. Addressable Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.
  - b. Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 63 appliances can be supported on a single channel.
  - c. Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.
- 2. Addressable Controller: Addressable Controller shall supervise Channel (SLC) wiring, communicate with and control addressable notification appliances. It shall be possible to program the High/Lo setting of the audible (horn) appliances by channel from the addressable controller.
- 3. Horn: Addressable horn shall be listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4"

square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.

- 4. Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.
- 5. Audible/Visible: Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:
  - a. Synchronized Strobe with Horn on steady.
  - b. Synchronized Strobe with Temporal Code Pattern on Horn.
  - c. Synchronized Strobe with March Time cadence on Horn.
  - d. Synchronized Strobe firing to NAC sync signal with Horn silenced.
- 6. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker operates on a 25VRMS or 70.7VRMS NAC.
  - a. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC using and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
  - b. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
  - c. The S/V shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
  - d. The S/V installs directly to a 4" square, 1 1/2 in. deep electrical box with 1 1/2" extension.
- 7. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:
  - a. Report faults to the host FACP.
  - b. On-board Yellow LED provides module status.
  - c. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.
- 8. Accessories: The contractor shall furnish the necessary accessories.

#### K. NAC Power Extender

- 1. The IDNet NAC Power Extender panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be Class B Style Y rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits.
- 2. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.
- 3. The NAC extender panel may be mounted close to the host control panel or can be remotely located. The IDNET Addressable NAC Extender Panel when connected to an addressable panel shall connect to the host panel via an IDNet communications channel. Via the IDNET channel each output NAC can be individually controlled for general alarm or selective area notification.
- 4. For IDNet connected NAC extender panels up to five panels can be connected on a single IDNet channel.
- 5. When connected to a conventional (non-addressable panel) one or two standard notification appliance circuits from the main control panel may be used to activate all the circuits on the NAC power extender panel.
- 6. Alarms from the host fire panel shall signal the NAC power extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.
- L. Circuit Conductors: Copper; power limited plenum rated; color code and label.
- M. Dwelling Units: 120V stand-alone combination photo-electric smoke detector and carbon monoxide detector, with battery backup and sounder for alarm.
  - 1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac. Smoke detectors shall be powered from nearest receptacle branch circuit within room.
  - 2. Auxiliary Relays: One Form A and one Form C, both rated at 0.5 A.
  - 3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
  - 4. Test Switch: Push to test; simulates smoke at rated obscuration.
  - 5. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
  - 6. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  - 7. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
  - 8. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
- N. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
  - 1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
- O. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.

- 1. Padlock eye and hasp for lock furnished by Owner.
- 2. Locate as directed by Owner.

## PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Fire Alarm System Installer shall be responsible for all electricals both 120V & low-voltage to their equipment/components.
- D. Obtain Owner's approval of locations of devices, before installation.
- E. Install instruction cards and labels.
- F. Install and connect Fire Dept. Connection Horn and Light furnished by Sprinkler Contractor.
- G. Install Fire Alarm System per construction phasing. Coordinate with Owner.
- H. Coordinate integration between Owner & Owner's preferred third-party security/monitoring company.

## 3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

#### 3.3 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
  - 1. Hands-On Instruction: On-site, using operational system.
- B. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
  - 1. Initial Training: 1 session pre-closeout.
  - 2. Final Training: 1 session 90-days after closeout.
- C. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

#### 3.4 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
  - 1. Be prepared to conduct any of the required tests.
  - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
  - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
  - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
  - 5. Repeat demonstration until successful.
- B. Occupancy of the project will not occur prior to Substantial Completion of each associated phase.
- C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
  - 1. Approved operating and maintenance data has been delivered.
  - 2. Spare parts, extra materials, and tools have been delivered.
  - 3. All aspects of operation have been demonstrated to Owner.
  - 4. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
  - 5. Specified pre-closeout instruction is complete.

#### 3.5 MAINTENANCE

- A. See Section 01 70 00 Execution Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.
- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:

- 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
- 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
- 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- D. Provide trouble call-back service upon notification by Owner:
  - 1. Provide on-site response within 2 hours of notification.
  - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
  - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- G. Comply with Owner's requirements for access to facility and security.

#### END OF SECTION 283100